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Feeding Heads Not Necessary

Practical Application of Pressure System of Pouring in a Nonferrous Foundry Would Seem To Indicate that the Method Is Preferable To the Use of Feeding Heads

BY ROY E. PAINE

TO OVERCOME the disastrous effects of shrinkage, foundrymen place feeding heads or risers on bulky castings or on castings with uneven thickness of metal. Feeding heads or risers seldom have proved satisfactory since they leave the castings depressed, shrink-holed or porous in

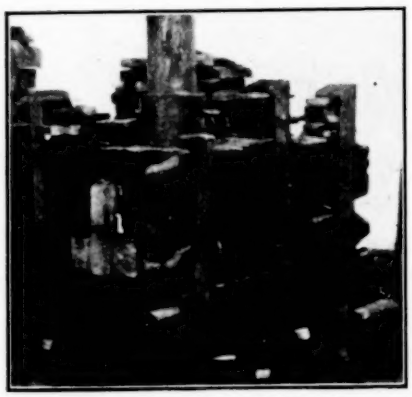


FIG. 1—HIGH HEADS NECESSITATE USE OF EXTRA CLAMPS

their vicinity. A method of pressure casting, successfully applied in a nonferrous foundry requires no feeding heads or risers, eliminates troublesome shrinkages, improves the quality of castings by preventing porosity, produces denser castings and reduces cleaning room cost because there are no large feeding heads, risers or gates to be removed.

In the latter part of 1920 F. W. Paine, for many years a brass foundryman of San Francisco noticed an article in a technical journal published several years previously, describing methods for making castings without risers. The article was illustrated with reproduction of photographs showing two castings gated in the usual manner at the bottom, but which had not been provided with risers of any kind. The idea impressed him so favorably that on the following day he tried it out in his own practice.

He cast some 4 x 12-inch, 5 x 12-inch and 6 x 12-inch solid phosphor bronze blocks without any feeders on top. He varied his method slightly from that shown in the original description and instead of pouring the metal through a square gate at the bottom, he employed a small horn gate ½-inch in diameter where it entered the mold in the center of the bottom face. The horn gate was connected to a 1-inch vertical gate that extended 18 inches above the top of the casting. Although no provision was made for feeding, a perfect casting was taken from the sand in each case and all the remaining castings on the order were cast successfully in the same manner. One of these solid pieces machined near the top presented a perfectly clean and solid surface. The method by which all the castings for the order were produced is shown in Fig. 7.

Fig. 5 represents a heavy bronze bushing which ordinarily would be poured with a heavy gate on one side of the top and a heavier riser on the opposite side. The casting probably would display a shrunken area in the vicinity of both, a feature that might make the end of the casting useless. The bushing was poured through a small round horn gate, the pouring end of which extended 22 inches above the top of the casting. About 25 of

FIG. 2—METHOD OF APPLYING PRESSURE GATE TO VALVE SEAT

these castings were poured by the pressure system.

The heavy locomotive bearing shown in Fig. 8 was cast from an alloy containing copper 80 per cent; tin 10 per cent and lead 10 per cent. The casting was made successfully several times in the manner illustrated. Shrinkage cavities, always in evidence when the gate and risers were cut in the usual manner, were not present.

A drawing of a heavy gun metal nut is reproduced in Fig. 6. Four of

these had been made six years before. At that time they were cast with the large end up and were gated with a square gate on the side at the bottom. The casting was fed for several minutes through a riser 3¾-inches in diameter, placed on top. The centers of these castings were so filled with shrink holes that they had to be scrapped. After much trouble the castings finally were delivered.

Last year an order was received for six additional similar castings. Under the pressure system method the job presented none of its former difficulties. Five nuts were cast in the position shown and one was cast in the opposite position. In the rough the castings presented a fine appearance and when the thread was cut through the center there was not the slightest evidence of shrinkage. The results obtained with these castings indeed were gratifying and helped to offset the memory of the first lot.

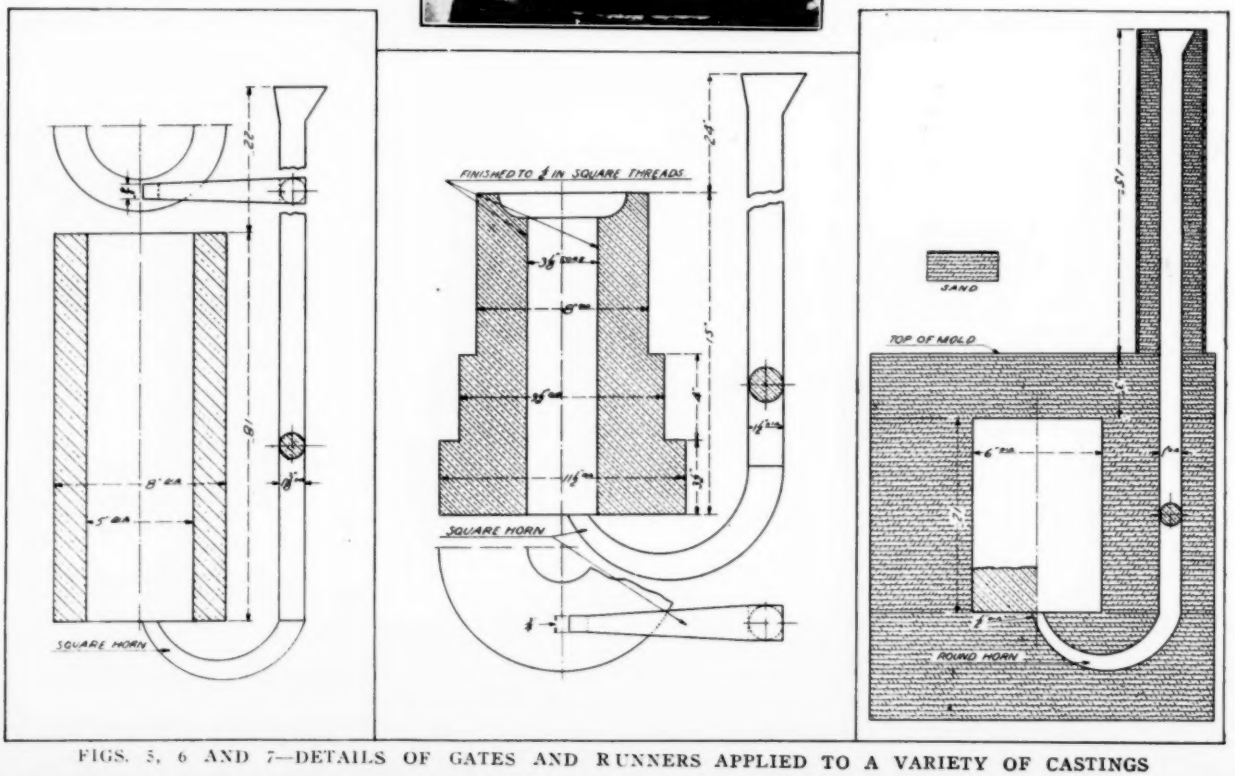
FIG. 3—SHOWING COMPARATIVE HEIGHT OF POURING HEAD

Phosphor bronze elevator gears of various sizes are cast every day with heavy gates and risers placed on the face. In the majority of cases the metal shrinks around the gate and riser and when the teeth are cut in the casting, shrink holes often render them useless. An elevator gear that has been cast many times with a pressure gate is shown in Fig. 10. The troublesome features incident to shrinkage have been overcome and the gears are perfect when machined.

Figs. 3 and 9 show a 3-inch strainer valve body cast from a steam metal alloy composed primarily of scrap. The casting weighs 300 pounds and must withstand a hydrostatic pressure of 500 pounds per square inch. The valve body is so constructed that heavy sections of metal are adjacent to light sections. These valves bodies formerly were cast with a gate along the side of one of the cylinders and with a heavy riser on the upper flange. The castings always leaked badly in the region of the gates and risers and in the drawn areas where heavy and light sections joined. With a pressure gate entering the casting on the lower flange along side the core and rising 22 inches above the top flange, the castings have been satisfactory. There is none of the former trouble from shrinkage in the uneven sections and the castings show no sign of porosity when under pressure. Detail views of the gate where it enters the castings are shown.

Fig. 4 illustrates a 1½-inch strainer valve body cast in large quantities. It is similar in construction to the 3-inch valve body and it has corresponding variations in the thickness of metal. Before the valves were cast with a

FIG. 4—AT THE LEFT—METAL ENTERS CASTING AT BOTTOM



FIGS. 5, 6 AND 7—DETAILS OF GATES AND RUNNERS APPLIED TO A VARIETY OF CASTINGS

pressure gate as shown they leaked badly and often were rejected in large quantities. Since a pressure gate has been employed not a single one has been rejected from this cause.

Fig. 2 shows the first of two bronze valve seats cast recently. It is 31 inches in diameter and weighs 650 pounds. It was designed with a heavy section of metal around the circumference. Two similar valve seats cast a few months before with two heavy gates on the side and a heavy riser on the center rib, drew badly around the riser and the shrink holes in the center of the gates were so large that they had to be burned in. The valve seat shown in the illustration was cast with a pressure gate on the face and the casting was perfect with the exception of a few slight surface defects due to gas.

Any foundryman who has made double runners knows that they often shrink around the riser placed on the center portion of the casting. This shrinkage is eliminated by the pressure system of castings and the proof is in the fact that several excellent runners were produced in this manner during the spring of last year.

System Difficulties

Foundrymen readily will realize that green sand molds must be rammed firmly to withstand the enormous pressure exerted by the metal while in a fluid condition. It has been found that the mold must be rammed harder than usual to prevent the metal from straining or from burning-in to the face of the mold. The strainer valve bodies shown in Fig. 4 are cast without any difficulty in blackened skin dried molds. The larger strainer valve bodies and other castings similar to those shown in Figs. 2, 9 and 4 are cast in well blacked skin dried molds rammed evenly and firmly. The mold must be weighted heavily or secured firmly to withstand the force exerted by the metal. A photograph of the assembled mold in which the valve seat pictured in Fig. 2 was cast is shown in Fig. 1. The mold was well secured with clamps and binders and weights were placed on top to prevent the sand from copeing. The illustration shows the provision made for the extra length of gate.

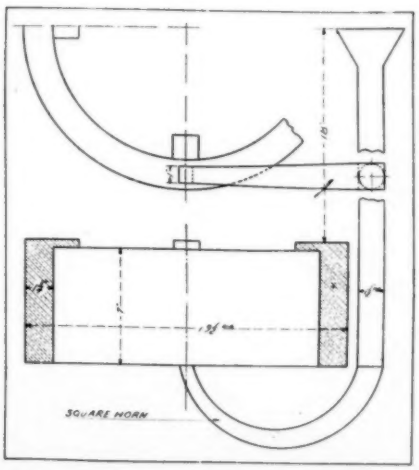


FIG. 8—METAL ENTERS THE CASTING AT THE BOTTOM OF THE BEARING

Core Mixtures

Cores probably have presented more difficulties than any other feature in connection with the system of pressure casting. In the small valve bodies shown in Fig. 4 portions of the cores

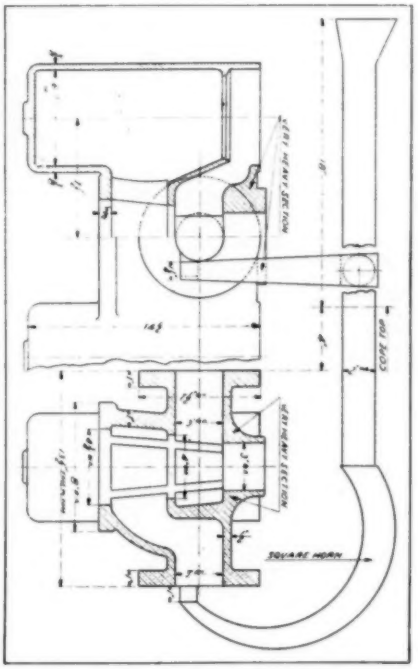


FIG. 9—THIS CASTING SHOWED NO POROSITY AT THE JUNCTION OF HEAVY AND LIGHT SECTIONS

burned in badly and too much time was required to clean them out. However, eventually a core mixture was developed which makes a core that does not burn in and that is removed easily. A serious core problem was presented by the valve seat shown in Fig. 2. A core was needed that would be firm, that would not burn in and that could be removed readily from the casting. The cores in the first casting burned in solidly and were removed only with the greatest difficulty. The cores in the second casting did not burn in, but they were rather hard and difficult to remove from the casting. A core mixture that will make a core with all the qualities desired for any casting that is to be produced may be determined by experiment and in no other way.

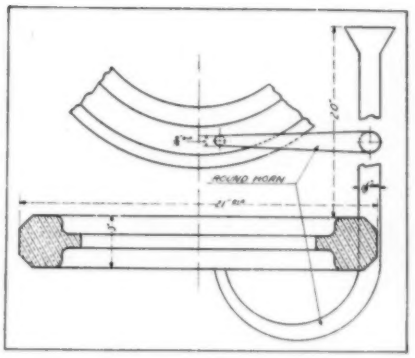


FIG. 10—ELEVATOR GEAR BLANK USUALLY PRESENTED POROUS AREAS UNTIL THE PRESSURE GATE SYSTEM WAS ADOPTED

Temperature of the metal exerts a great influence on the successful application of pressure casting. We have not employed a pyrometer in our practice and therefore no definite data can be presented on the temperature at which we have been pouring castings. In accordance with the age-old eye test we pour castings with hot metal. On some occasions when the metal was cooler than usual the small valve bodies shown in Fig. 4 were badly shrunk and on several occasions solid rods were depressed on top on account of cool metal. Undoubtedly satisfactory results may be obtained by the foundryman who determines the temperature of his metal by pyrometric control and not by measurement made by the naked eye.

The pressure system of pouring castings offers several advantages. In the first place it is not necessary to make provision for risers, feeding heads and heavy gates and therefore the difficulties arising from their use is not experienced. Castings do not have to be burned where shrinkage has left large holes at the gate, riser or feeding head.

Costs Reduced

In the second place there are no porous sections in castings with uneven thickness of metal. In the third place the pressure produces a denser casting than one poured in the ordinary manner. In the fourth place the cost of cleaning castings is reduced. There are no heavy gates, risers or feeding heads to be cut off and finally, the castings made in presure molds present a clean surface on leaving the sand.

The system of pressure gating castings offers innumerable possibilities. Foundries may secure excellent results by applying the system to the production of valve bodies of every description, bushings, gears, pump bodies,

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Consider Chemical Limitations

American Society for Testing Materials Discuss Requirements for Steel Castings and Debate Chemical as Well as Physical Specifications for Cast Iron

CHANGES recommended in the standard specifications for steel castings of the American Society for Testing Materials were incorporated in a new specification adopted as tentative at the annual meeting of the society held at Atlantic City, June 25 to 29. The new specifications, shown in the accompanying table, provide for two classifications, as in the former specifications, class *A* with chemical analysis only, specified, and class *B* having both chemical and physical properties specified. Reference to pattern has been omitted as unnecessary in a material specification. Carbon for class *A* has been raised from 0.30 to 0.40 per cent maximum to bring this in agreement with current practice. Also ductility requirements for elongation and reduction of area have been increased to bring them in line with results being obtained in modern practice.

Richard Moldenke, Watchung, N. J., chairman of committee *A*-3 on cast iron, presented a progress report indicating that the subcommittees are considering changes in the present tentative specifications for chilled iron car wheels, for pig iron, and for high test cast iron. In the latter specification a method of measuring the deflection between loads of 50 pounds and 3500 pounds, instead of from zero load to breaking load has been proposed. It also has been decided to include a table for correcting the results of the transverse test for variations in the thickness of the bars.

The question of whether it is desirable to include chemical requirements in specifications for cast iron was discussed in an interesting manner. Robert Job, vice president, Milton Hersey Co., Ltd., Montreal, Canada, leading the argument for the affirmative, in a preprinted paper, followed by an argument for the negative by Richard Moldenke, consulting engineer, Watchung, N. J.

Mr. Job, while admitting that, theoretically, physical tests could be made to determine the relative fitness of an iron casting for any given purpose, says that present knowledge as to physical tests is often insufficient to determine definitely the meaning of these tests in terms of actual service of the casting under practical working conditions. Owing to this lack of knowledge, he maintains that supplementary chemical as well as physical tests have been proved necessary by practical experience, to secure efficient service from the castings.

Chilled iron car wheels are cited as an example of this, and it is claimed that a wheel may meet all the physical tests required and still be unfit for service on account of too high combined carbon, as indicated by wheels which have failed in service. Steam cylinders of a locomotive are used as an illustration where the iron is entirely different from that in chilled iron wheels. Here resistance to shock and abrasive action is said to be required, but no physical tests, it is claimed, have been developed by which the quality of the cylinder can be determined definitely, and it is the custom to hold the chemical composition within certain limits. Mr. Job maintains that for specifications the simplest arrangement is desired both of physical or chemical tests, which will insure the properties proved by experience to be necessary to meet the conditions in service.

Dr. Moldenke advances two general reasons why the introduction of chemical requirements into the usual specification for iron castings is undesirable. The one is that wherever this has been tried in a general way it has failed in its purpose. The case it cited of one prominent engineernig society which went into the subject and found that to include all the compositions of castings coming under each separate line of work for which special specifications were to be prepared, would mean that the limits for the several elements in cast iron would have to be held so wide that no useful purpose would be served. The second reason given is that the history of the development in foundry practice has shown that present-day compositions of castings are considerably different from what was considered necessary some years back. Dr. Moldenke gives silicon as an example, and says that with more knowledge of the bad effects of dissolved iron oxide in cast iron, and definite information on the progression of cupola melting, the same grades of soft iron castings are now produced with much lower silicons than formerly. The general use of steel scrap in the mixtures is given as another instance requiring different compositions to produce the physical effects as were obtained by using straight iron in mixtures.

Dr. Moldenke agrees that where it is known definitely that when a given maximum percentage of an element is exceeded, failure may result it is wise to include this limit in the specifications. However, he contends that the foundryman should not be burdened with a full line of chemical requirements in addition to physical tests.

An interesting discussion from the floor followed the presentation of the two sides and it developed that the opposing ideas are not greatly in disagreement. It was generally agreed that certain types of castings such as car wheels require chemical limits in the specifications. However, a vote showed that the sentiment of the meeting was two to one in favor of omitting chemical requirements on all cast-iron specifications except in cases such as those given.

Nonferrous Featured

NONFERROUS subjects featured the opening session of the twenty-fifth annual meeting of the American Society for Testing Materials. After reports of committees and the presentation of papers announcement was made of the election of officers to serve the coming year, as follows: President, Guilliaem Aertsen, Midvale Steel & Ordnance Co., Chicago; vice president, W. H. Fulweiler, chief chemist, United Gas Improvement Co., Philadelphia. Those elected members of the executive committee were J. H. Chubb, manager service bureau, Universal Portland Cement Co., Chicago; H. L. Scott, Henry L. Scott & Co., Providence, R. I.; and P. H. Walker, chemist, United States bureau of standards, Washington.

Committee B-2, on nonferrous metals and alloys, William Campbell, chairman, recommended the following tentative standards be advanced to standard: Specifications for pig lead; for brass pipe, standard sizes; and for copper pipe, standard sizes; also tentative methods of chemical analysis of brass ingots; of bronze bearing metals; and of nickel. The subcommittee on sand-cast metals

(*Concluded on Page* 564)

Specifications for Steel Castings Adopted as Tentative by the American Society for Testing Materials at Atlantic City, June 25, 1923

Material Covered

1. These specifications cover steel castings for general service and for ships. Two of castings are covered: namely,

Class A, castings for which no physical requirements are specified.

Class B, castings for which physical requirments are specified.

These are of three grades: hard, medium, and soft.

I. Manufacture

Process

2. The steel shall be made by one or more of the following processes: open-hearth, electric furnace, converter, or crucible.

Heat Treatment

3. (*a*) Class A castings need not receive any heat treatment unless so specified, or unless the carbon content exceeds 0.30 per cent.

(*b*) Class B castings shall receive a proper heat treatment, the treatment depending upon the design and chemical composition of the castings.

(*c*) Heat treatment shall be in accordance with the society's standard practice unless otherwise specified by the purchaser.

II. Chemical Properties and Tests

Chemical Composition

4. The castings shall conform to the following requirements as to chemical composition:

	Class A	Class B
Carbon	not over 0.05 per cent	....
Phosphorus, Acid	not over 0.07 per cent	not over 0.06 per cent
Phosphorus, Basic	not over 0.06 per cent	not over 0.05 per cent
Sulphur	not over .... per cent	not over 0.06 per cent

Ladle Analyses

5. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 4. This anaylsis shall be made from drillings taken at least ¼ in. beneath the surface of a test ingot obtained during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirments specified in Section 4.

Check Analyses

6. (*a*) Analyses of Class A casings may be made by the purchaser. The phosphorus content thus determined shall not exceed that specified in Section 4 by more than 20 per cent. Samples for analysis shall be taken not less than ¼ in. beneath the surface, and in such a way as not to destroy the castings.

(*b*) Analysis of Class B castings may be made by the purchaser from a broken tension test specimen. The phosphorus and sulphur content thus determined shall not exceed that specified in Section 4 by more than 20 per cent.

III. Physical Properties and Tests (For Class B Castings only.)

Tension Tests

7. (*a*) The castings shall conform to the following minimum requirements as to tensile properties:

	Hard	Medium	Soft
Tensile strength, lb. per sq. in.	80,000	70,000	60,000
Yield point, lb. per sq. in.	0.45 tens. str.	0.45 tens. str.	0.45 tens. str.
Elongation in 2 in., per cent	17	20	24
Reduction of area, per cent	25	30	35

(*b*) No limit shall be placed on the tensile strength in any of the grades.

(*c*) The yield point shall be determined by the drop of the beam of the testing machine.

Bend Tests

8. (*a*) Bend tests shall not be required for castings of the hard grade, and shall be required for castings of the medium and soft grades only when so specified in the order.

(*b*) When a bend test is specified, the test specimen shall withstand being bent cold without cracking on the outside of the bent portion, around a pin 1 in. in diameter to the following angles:

	Hard	Medium	Soft
Angle of bend	No Bend Test	90 degrees	120 degrees

Alternative Tests to Destruction

9. The tensile properties of the castings shall be determined from test bars unless in the case of castings weighing not over 150 lb., the manufacturer desires to offer, as an alternative, tests to destruction. Upon agreement with the inspector, the castings shall be grouped in lots, each lot containing castings from the same melt and from the same heat-treatment charge, and the inspector shall select from each lot one casting to represent the lot. The representative casting shall be tested to destruction as a substitute for the tension test. This test shall show the material to be ductile and free from injurious defects.

Test Specimens

10. (*a*) Tension and bend test specimens shall be taken from test bars cast attached to the castings where practicable. If the design of the castings is such that test bars should not be attached to the castings, the test bars shall be cast attached to special blocks, of which a sufficient number shall be provided for each lot of castings. Test bars from which tension and bend test specimens are to be taken shall remain attached to the castings or blocks they represent through heat treatment and until presented for inspection. Test bars shall be provided in sufficient numbers to furnish the tests required in Section 11.

(*b*) If satisfactory to the manufacturer and inspector, tension test specimens may be cut from heat-treated castings instead of from test bars.

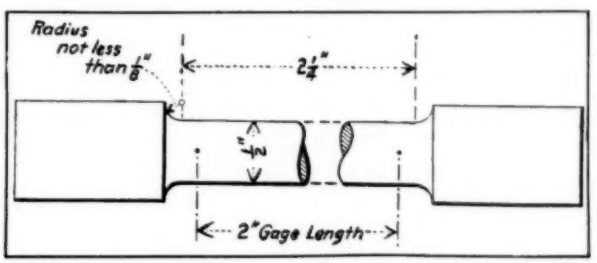

FIG. 1—STANDARD TEST BAR FOR STEEL CASTINGS

The gage length, parallel portions and fillets shall be as shown, but the ends may be of any form which will fit the holders of the testing machine.

Test Specimens

(*c*) Tension test specimens shall conform to the dimensions shown in Fig. 1. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

Bend Specimens

(*d*) Bend test specimens shall be machined to 1 by ½ in. in section with the corners rounded to a radius of not over 1/16 in.

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Specifications for Steel Castings Adopted as Tentative by the American Society for Testing Materials at Atlantic City, June 23, 1923

(*Concluded from Page 563*)

Number of Tests

11. (*a*) One tension test and, when specified, one bend test shall be made from each melt in each heat-treatment charge and, when specified, from each casting weighing 500 lb., or over.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded; in which case another specimen from the same lot shall be substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 7 (*a*) and any part of the fracture is more than ¾ in. from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Retests

12. If the results of the physical test for any lot do not conform to the requirements specified, such lot may be retreated, but not more than twice. Retests shall be made as specified in Sections 7 and 8.

IV. Workmanship and Finish

Workmanship

13. The castings shall conform substantially to the shapes and sizes indicated by the patterns and drawings submitted by the purchaser.

14. (*a*) The castings shall be free from injurious defects.

Finish Welding

(*b*) Defects which do not impair the strength of the castings may be welded by an approved process. The defects shall be cleaned out to solid metal, before welding, and when so required by the inspector, shall be submitted to him in this condition for his approval. When required by the inspector, important castings shall be heat-treated after welding.

V. Inspection and Rejection

Inspection

15. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications.

(*b*) If, in the case of important castings for special purposes, surface inspection in the green state is required, this shall be so specified in the order.

(*c*) All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection

16. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 6 shall be reported within five working days from the receipt of samples.

(*b*) Castings which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected and the manufacturer shall be notified.

Rehearing

17. Samples tested in accordance with Section 6, which represent rejected castings, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

VI. Special Requirement for Castings for Ships

Castings for Ships

18. In addition to the preceding requirements, castings for ships, when so specified, shall conform to the following requirements:

19. All castings shall be of Class B, medium or soft grade, and shall receive a proper heat treatment.

20. (*a*) One tension and one bend test shall be made from each of the following castings: stern frames, stern posts, twin screw spectacle frames, propeller shaft brackets, rudders, steering quadrants, tillers, stems, anchors, and other castings when specified.

(*b*) When a casting is made from more than one melt, four tension and four bend tests shall be made from each casting.

Percussion Tests

21. (*a*) A percussion test shall be made on each of the following castings: stern frames, stern posts, twin screw spectacle frames, propeller shaft brackets, rudders, steering quadrants, tillers, stems, anchors, and other castings when specified.

(*b*) For this test, the casting shall be suspended by chains and hammered all over with a hammer of a weight approved by the purchaser or his representative. If cracks, flaws, defects, or weakness appear after such test, the casting may be rejected.

Nonferrous Featured

(*Concluded from Page 562*)

and alloys reported the investigation of the subject of a standard test bar well under way, a number of manufacturers of cast metals, including the U. S. bureau of standards, having started a series of comparative tests on a test bar, the requirements of which have been specified by the committee.

The paper on methods of casting test specimens of gun metal by E. H. Dix Jr., chief of the metallurgical branch, engineering division, air service, McCook field, Dayton, brought out strong discussion as to the intent of the test bar.

It was admitted that the test bar does not represent the casting and it was urged that the society state in its specifications that the strength of the casting should be considered in a stated ratio to the strength of the test piece thereby clarifying the interpretation of results and data obtained in experimental tests.

Book Review

Aluminum Repairing, by William H. H. Platt, cloth, 70 pages, 5 x 7¼; published by Crosby, Lockwood and Son, London and by D. Van Nostrand Company, New York, and supplied by The Foundry, Cleveland, price $1.50, net.

The foundry which specializes in the production of aluminum castings may find this little book a source of information in the repair of various kinds of aluminum work. Explicit directions are given for the correct use of the tools of the trade and detailed explanations of the steps in the repair of radiator tops, gear cases, side standards, etc. Several chapters are given over to the procedure to follow in shortening cast aluminum pipe, making of socket and flush joints and the methods of reducing holes in castings to be rebored or machined.

The author gives his formulas and the composition of the alloys he uses as well as the methods which he claims have been in use for some time and found to be practicable.

Foundry Costs Simplified--III

Materials and Supplies Controlled by Perpetual Inventory, Stores Requisition and Credit Forms—Knowledge of Stock Condition Enables It To Be Kept Within Limits—Thirty-Day Turnover of Stocks Recommended

BY ALFRED BARUCH

MATERIAL costs are easier to keep in the foundry than in any other industry. The reason for this is that the material is of a similar character. In a gray iron foundry the number of items in the inventory would be small since it contains only the names of the various grades of iron used. However, the foundry has to use many varieties of supplies which need careful watching.

The raw materials and supplies are accounted for in the same manner—through the use of a perpetual inventory. Where the foundry is quite small the inventory as to materials can be dispensed with and stock records kept of the supplies only. Since in the small jobbing shop the pig iron usually is kept in the open yard and stacked in piles so that their quantity and weight can be determined by a glance, a rough count of the iron once a week will enable the foundrymen to reorder in sufficient time to keep from being held up on account of no iron.

The foundry is really a continuous process plant. When the cost of metal at the spout has been determined, no more costs can be added to the metal itself since it has reached its final form and undergoes no further conversion. The entire problem of accounting for the cost of material in a foundry is thus concerned with the finding of the cost of melting the iron and adding this cost to the original purchase price.

The cost of iron in the yard is made up of the purchase price plus freight, demurrage, and handling. The rest of the cost is made up of melting labor, maintenance, supplies, and apportioned expenses. The cost of melting labor consists of the wages of the melting department foreman, if one is employed, or else of a part of the wages of the molding foreman who would supervise the melting as well; of the wages of labor used in unloading iron and other melting materials; of the wages of the cupola loaders; of the wages paid for breaking scrap; of the laboratory expenses used in testing iron; of the money paid for sickness or accident relief; and finally of the wages of miscellaneous labor used for removing slag and doing any other work in the yard or about the foundry.

The maintenance cost is composed of the labor and material necessary for repairing the building, cupolas, elevator, pipe and power lines, and the loading platform and stairways. The cost of supplies is made up of such items as coke, kerosene, wood, fire sand, limestone, fire brick, clay, and other lining materials. The apportioned expenses consist of the melting department's share of the cost of compressed air, heat, light, power and general expense. The total of these expenses make up the melting cost. To find the cost of one pound of metal at the spout it is necessary to take the sum of these expenses for an average month and divide them by the number of pounds melted in an average month.

THE author in this article gives a clear exposition of the uses and needs for including a complete system of stock records and emphasizes the necessity that orders be written for all stock and supplies. A loose system of keeping stock records is one of the faults in many foundries, not enough emphasis being put on this phase of cost keeping. Attention to the points brought out in this article will convince the reader of the importance of accurate stock records, as the advantages are fully indicated.

The stock record, Fig. 3, can be made up of the various kinds of iron; the scrap, which is bought from the junk dealer, and that which is produced as a result of defective work in the foundry. But the greater part will be the record of supplies which make up nearly 20 per cent of the cost of the metal. These records are printed on cards 5½ inches long and 8½ inches wide.

The stock record, Fig. 3, contains in its heading the name of the article and a description of it by size and unit if possible. The body is divided into four sections which are headed: ordered, received, issued, and on hand. The *ordered* section is sub-divided into columns which show the date, the order number, the quantity, and the total. The *received* and *issued* sections are also sub-divided in the same way except that they have no column for quantity which is merely added to the running total. The difference between the *received* and *issued* section is the balance which is shown in the column headed *quantity* in the *on hand* section. The remainder of the columns in this section are headed current price, amount, and adjustment. This last section is reserved for any physical counts that may be made that do not check up with the balance on hand. These counts are taken periodically to test the accuracy of the stock records.

In deciding on a quantity of metal and supplies to be carried it is best to establish minimum and maximum limits. The minimum limit represents the least quantity of material that can be carried without putting the foundry in danger of having to shut down because of lack of metal or essential supplies. The maximum limit represents the greatest quantity of metal and supplies that the owner is willing to carry at any one time. The balance should always range between these two limits. The importance of maintaining the supplies within the established limits cannot be over emphasized. These limits are determined by experience, and to ignore them even for a little while means taking an unnecessary and unbusiness like risk. They insure the work being done properly and efficiently. They prevent the inventory from tying up too much money. They serve as a measure of the business by pointing out the rate at which metal and supplies are being used and therefore the rate at which production is going.

To get production started it is necessary to take an inventory of all the stock, and this performance should be repeated at least once a year to determine what the profits are. The usual method of taking inventory is to list the kinds and quantities of material on a sheet of paper and to count each unit or each piece. This count has to be made several times to make sure of its accuracy.

PERPETUAL INVENTORY

KIND_____ MINIMUM_____ MAXIMUM_____

UNIT_____ SIZE_____ LOCATION_____

ORDERED				RECEIVED			ISSUED			ON HAND			
DATE	ORDER NO	QUANTITY	TOTAL	DATE	ORDER NO	TOTAL	DATE	ORDER NO	TOTAL	PRICE	AMOUNT	QUANTITY	ADJ.

FIG. 3—PERPETUAL INVENTORY IS KEPT ON A STOCK RECORD CARD

The above method will do well enough for the monthly or weekly physical count since the foundry that keeps no stock records is usually so small that it is possible to take an inventory in two hours. However, this method is hardly sufficient for a complete check of the stock on hand, such as is necessary at the end of the year.

When the big annual inventory is taken, before getting out the financial statements, a great deal more care must be exercised, particularly as the valuation of the metal and supplies will have a great effect on the profit or loss. The inventory should be taken by the shop foreman. They must count the pieces, and weigh them, if necessary. Then they must write the description and quantity on both sides of a perforated tag provided for the purpose. The serial number of the tag must be stamped on both the coupon and the stub so that they may be matched afterward. The tag is attached to the pile or the bin and then the coupon is torn off and taken to the office.

These coupons are then sorted according to classes and the total for each class is entered on a material sheet. This sheet is ruled off so as to allow the items to be listed according to class, quantity, price, and amount. After all the classes and quantities as shown by the coupons have been entered on the sheet, the stubs are collected and brought in. The stubs are then matched up with their coupons and wherever this is successful the quantity represented by the stub and coupon is checked off on the big sheet. Those coupons and stubs that cannot be matched are investigated specially and the correct report on them is entered on the big sheet when the investigation is completed.

This method eliminates all the difficulties of the old fashioned way of taking inventory It is practically impossible to get a correct inventory in the old way. And when it is obtained, it requires a great deal of time and effort. The old way is to take the inventory twice for checking. When mistakes are discovered, as they always are, the only way to locate them is to take the inventory a third time and sometimes a fourth The new method automatically sorts out the mistakes because the stock is counted when the tag is put on and counted again when the stub is removed. If the quantity on the stub does not agree with the quantity on the coupon, or if the stub and coupon cannot be matched, a special check is made of these exceptions. In other words, the new method recounts only the mistakes while the old one recounts the entire stock when mistakes occur. It is a great time saver. The valuation of the individual items and the extensions can be made after the count is corrected.

It is usually difficult to induce a foundryman to draw his stores out on requisition. His motives are difficult to understand because he will insist that his bookkeeper balance the books even if he has to spend a whole day in running down a few pennies. The material and supplies represent cash and should be treated with the same consideration. Written records are always time savers since they standardize the routine and enable the men to do the same thing the same way all the time. This is an easy thing to do in the foundry since there are few items, and records for some of them must be kept under any condition.

In the case of iron and coke the daily melt sheet acts as a report of the material consumed and is used as the basis for stock record entries as well as for production statistics. The withdrawal of any stores must be acknowledged by a written requisition, signed by the foreman of the department. The requisition, shown in Fig. 4, is collected by the storekeeper, if there is one, or else by the foundry clerk. If the clerk has to look after stock as well, arrangements must be made to have all withdrawals made only once a day.

The store's requisition, Fig. 4, must show the serial number of the requisition, the department to which the stores are issued, the date the quantity, unit, description, and size. Check mark is placed after the word *partial* or *complete* according to whether all the stores needed for any one job were drawn at one time or in sections. Columns for price and amount must also be carried on the requisition so that extensions can be made in the office, when an effort is made to keep actual costs. Then the requisitions are priced according to the daily market. Where this method is not used, the extensions are made only for special jobs where all material and stores used on them must be charged.

Of course, it is better to charge iron and supplies with actual cost as nearly as possible. If the requisition is not priced as withdrawals are made, the value of material and stores consumed must be arrived at through the

METAL CREDIT SLIP

DATE_____ ORDER NO._____

QUANTITY	UNIT	DESCRIPTION	PRICE	AMOUNT

ORDER CREDIT STOCK CREDIT O.K.

FIG. 5—A FORM SHOULD BE PROVIDED FOR RECORDING METAL CREDITS

STORES REQUISITION

DEPARTMENT_____

PARTIAL_____

COMPLETE_____ DATE_____ ORDER NO._____

QUANTITY	UNIT	DESCRIPTION	SIZE	PRICE	AMOUNT

ISSUED BY_____ FOREMAN'S O.K._____

FIG. 4—REQUISITIONS SHOULD BE FURNISHED FOR ALL SUPPLIES

prevailing market rate at the end of the month when the statements are made up or else at an average rate for the month since it is impossible to trace back the original price. The average rate is unsatisfactory because the stores are not withdrawn in even quantities and the price distribution would therefore not be just.

The price entered on the requisition must make due allowance for freight, cartage, and handling or else these items must be added as a separate charge. This method is possible in the foundry since comparatively few jobs require special materials which must be ordered separately. In addition to the freight charge a handling charge must be made for material since the yard gang and the maintenance and rent of the store room involve certain expenses which must be accounted for. However, these charges can be made at the end of the month on the basis of a flat percentage of the metal poured.

As scrap returns from overshot, spills, bad castings, etc., form a considerable item in the foundry, it is necessary to establish some method of getting scrap and return supplies into the record. This is done through the use of a credit slip, an illustration of which is shown in Fig. 5. This slip is similar to the stores requisition in form but its function is reverse. It is the authority to add to the quantity on hand as shown by the stock records instead of deducting. Foundry scrap must be treated in exactly the same way in the records as if it were purchased outside.

The stock record system is maintained in the office by the bookkeeper or some other clerk. It provides records of working accuracy as to the quantity of each kind of stores on hand. Its chief function is to perform certain duties in the office and on paper that must otherwise be done by one or more employes in person and take a great deal of time.

The first use of the stock record system is in connection with purchasing. The foundryman or his agent who does the purchasing consults the records periodically to determine what supplies must be reordered. A good way is to set aside one day of the week on which all purchase orders are issued. The purchaser examines each card and wherever he finds a material that is approaching its minimum limit and is not likely to last through another week, he places this item on the order list. This examination requires only a few minutes and by making it a part of the weekly routine all delays due to lack of supplies are eliminated. The purchaser soon acquires great familiarity with the cards and therefore with the rates of consumption, and this enables him to take advantage of any market conditions that might result in profit.

It is impossible to make a statement of profit or loss over any period without a knowledge of the material and supplies on hand at the time of the statement, and of the material and supplies consumed since the last statement was made. The perpetual inventory is used once a month or once a week for the same purpose that the annual inventory was used in the past. The oftener a man knows whether he is making or losing money, the oftener can he change his policies to convert losses into profits.

Unless times are abnormal and it is difficult to obtain iron and supplies, it is most profitable to operate the foundry on a thirty-day basis. That is, the investment in material and supplies should be turned over at least once a month. That is possible if the purchaser will order close to the minimum limit and keep constant watch on the consumption. To do this successfully it is necessary to discount all bills promptly so as to establish good credit standing and induce the supply houses to take small orders on the same basis that they would big ones. Since it is not likely that the foundry's customers will pay promptly it is necessary to have constant recourse to the bank in order to borrow the money to discount bills. The bank lends on liquid assets, accounts receivable, and inventories. The bank has little faith in an inventory that is not based on perpetual stock records.

In case of fire, the stock records are used as the basis of any claim against the insurance company. It has been difficult in the past to establish claims that the adjusters will allow simply because of a lack of supporting evidence. The stock records serve this purpose.

The stock records are also used to detect theft. When a physical count of the stores shows a marked discrepancy with the stock record balance a check is at once instituted. If the stores requisitions and the invoices support the inventory, and the actual count is known to be correct, the explanation for the difference may be found in the fact that someone has made away with the stores. Of course, men are not likely to carry off pigs of iron. But there are other supplies of small bulk and high value. Recently the writer has had the satisfaction of having this fact proved and his methods vindicated. The owner of a clothing factory in which a stock system had been installed complained of its inaccuracy. A systematic investigation proved that he was being robbed by some of his men and he saved enough in a few weeks to pay for the original cost of the system.

Producers Standardize Crucible Sizes

The plumbago crucible manufacturers of the United States recently have completed, after more than two years' investigation, planning and experimentation, the standardization of crucible sizes. Exterior shapes and dimensions were worked out for each size so that they would have a true and uniform relationship to every other size, the basis for capacity being 3 pounds of molten copper per number with an allowance of 10 per cent for working space. It was found that this gives an increased capacity on the larger sizes, but that on the sizes from No. 100 down it gives

Standard Sizes of Brass Crucibles

Number	Height Inches	Top Inches	Bilge Inches	Bottom Inches	Approx. Cap. in Pounds Water
0	2	1 5/8	1 3/4	1 1/4	
00	2 1/4	2	2	1 1/2	
000	2 5/8	2 1/8	2 1/8	1 5/8	
0000	3	2 5/8	2 5/8	1 3/4	
1	3 5/8	3 1/8	3 3/8	2 3/8	39
2	4 1/4	3 1/2	3 7/8	2 7/8	78
3	4 7/8	4	4 1/2	3 1/2	1 17
4	5 1/2	4 1/2	5	3 3/4	1 82
5	6 1/8	4 7/8	5 5/8	4	2 21
6	6 1/2	5 1/4	5 5/8	4 1/4	2 60
8	6 7/8	5 7/8	6 1/2	4 1/2	3 13
10	8 1/8	6 1/8	6 5/8	4 3/4	4 8
12	8 1/2	6 5/8	6 7/8	5 1/8	5 6
14	8 7/8	6 3/4	7 1/8	5 1/4	6 4
16	9 1/4	6 3/4	7 1/2	5 1/2	7 2
18	9 3/4	7 1/8	7 3/4	5 3/4	8 6
20	10 1/8	7 3/4	8 1/8	6 1/8	10
25	10 3/4	8 1/8	8 7/8	6 1/2	12
30	11 1/2	8 5/8	9 1/8	6 3/4	14
35	12	9	9 1/4	7 1/8	16
40	12 1/2	9 3/8	10 1/8	7 1/8	18
45	13 1/8	9 7/8	10 3/4	7 3/4	21
50	13 3/4	10 1/4	11 1/8	8 1/8	24
60	14 1/8	10 3/4	11 3/4	8 1/4	28
70	15 1/8	11 1/4	12 1/8	8 3/4	32
80	15 5/8	11 3/4	12 3/4	9 1/4	36
90	16 1/4	12 1/8	13 1/8	9 1/2	40
100	16 3/4	12 1/2	13 1/2	9 7/8	44
125	17 3/8	13	14 1/8	10 1/4	50
150	18 3/8	13 3/4	14 7/8	10 7/8	60
175	19 1/4	14 3/8	15 5/8	11 3/8	70
200	20	15	16 1/4	11 7/8	80
225	20 3/4	15 1/2	16 3/4	12 1/4	90
250	21 3/8	16	17 1/8	12 3/4	100
275	22	16 1/2	17 3/4	13	110
300	22 1/2	16 7/8	18 1/4	13 3/8	120
400	24 1/8	18 1/8	19 1/4	14 1/8	160

1 lb. water = .96 pints or 27.7 cubic inches.

SIZES AND NUMERICAL DESIGNATION FOR STANDARD CRUCIBLES

a smaller crucible than had previously been supplied by most of the crucible manufacturers. Therefore, a crucible user who, for example, had been using a No. 50 pot, would have had to order a No. 60 in the new size to get the capacity to which he had been accustomed. However, to avoid confusion with the trade it was determined to adopt the new standards on the basis that had been developed and step them back to the next lower number covering all sizes below No. 100. The dimensions of a theoretical No. 110 pot were used for the new No. 100 size. Under this plan, practically all of the new sizes come close to the average capacities of the old style pots formerly manufactured, and the user may continue to purchase the size to which he is accustomed.

Note Points on Steel Casting

Opportunity for Comparison of American and European Practice Is Presented by Annual Meeting of the Institute of British Foundrymen—Consider Sand Tests

AMERICAN and British steel foundry methods show more points of similarity than divergence. In converter and open-hearth shops the practice of the two countries is identical in many respects, and the physical and chemical characteristics of the castings show considerable similarity. While still preferring acid steel for many purposes, British users of steel castings are showing a growing appreciation of the field for the basic open-hearth furnace. British foundrymen also express hearty sympathy with the American method of setting up specifications for steel castings through co-operation between the producers and consumers. On the other hand electric steel is not making the progress in England that it is in America, and there also exists considerable sentiment in the old country in favor of the basic-lined electric furnace.

COMING ABOARD FOR THE ANNUAL OUTING OF THE I. B. F.

OLIVER STUBBS, ELECTED PRESIDENT, STROLLS ON DECK

JACK ROBINSON AND OTHERS VIEWING THE SHIP CANAL

Exchange Paper Read

These were some of the chief points of international technical interest brought out at the twentieth annual meeting of the Institute of British Foundrymen, at Manchester, England, June 13-15. In accordance with the usual custom at the annual meeting only four papers were read and discussed at the two morning sessions, the majority of this society's papers being presented during the fall and winter at monthly meetings held by the 11 branches of the institute. Two of the four papers dealt with steel foundry practice, one being the exchange paper presented on behalf of the American Foundrymen's association by Major R. A. Bull, research director, Electric Steel Founders Research group, Chicago. This paper which is appearing in THE FOUNDRY is a broad and comprehensive survey of American steel foundry practice, entitled "The Manufacture of Steel Castings in the United States." The other steel paper, which was entitled, "The Manufacture of Steel Castings and Preparation of Sand," by F. A. Melmoth, Braintree Castings Co., near London, dealt with the subject from the British standpoint. An unusually favorable opportunity therefore was afforded to make direct comparisons between the steel foundry methods of the two countries. The two remaining papers were concerned with core-room and gray-iron foundry practice respectively.

The meetings were held at the Manchester College of Technology. The proceedings were opened on Wednesday morning, June 13, with an address of welcome from W. Cundiff, lord mayor of Manchester, who then presented the Oliver Stubbs gold medal to W. H. Sherburn, Richmond Gas Stove Meter Co., Worrington, in recognition of his work in the early days of the British Foundrymen's association, and for his paper on "The Evolution of the Foundryman," which has been widely distributed among workmen by large British employers.

It was announced that to conform with certain provisions of the royal charter the name of the association has been changed from Institution of British Foundrymen to Institute of British Foundrymen. This change was unanimously approved by the members present at the Manchester conference, and the word "Institute" hereafter will be used in the title of the society.

Broadcast Greetings

Before the reading and discussion of papers started, the newly elected president, Oliver Stubbs, Joseph Stubbs Ltd., Manchester, was conducted to the chair. This is Mr. Stubbs' second term of office. He was president in 1921-22, during which period he paid an official visit to the United States. Some of the features of his annual address have already been published. He emphasized the necessity for forstering foundry education and recommended the establishment of junior branches of which boys interested in foundry work could be members. He also pointed out the importance to the institute of the complete organization of its various branches which now cover the entire British isles.

Mr. Stubbs again referred to the importance of the cordial international relations which are being fostered through the co-operation of the Institute of British Foundrymen, the American Foundrymen's association, and the Association Technique de Fonderie de France. He said he hoped a large number of American foundrymen would come to Europe in September to join with the British foundrymen in making the international foundrymen's congress in Paris a success. He traced at some length the growth of the movement toward greater international co-operation between foundrymen, in which he has

taken a special interest. At the conclusion of the session greetings from the British foundrymen were telegraphed to the French and American associations.

A special welcome was extended to two visitors from the United States, Henry M. Lane, head of the H. M. Lane Co., Detroit, and A. O. Thomas, Detroit, who is associated with Mr. Lane.

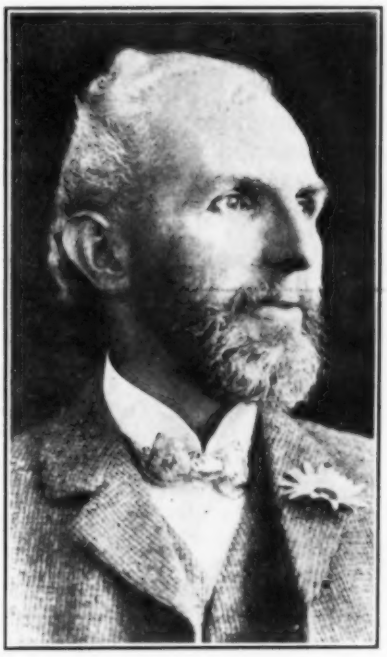
Dry at Low Temperature

The first paper presented was entitled "Oil-Sand Cores and Binders," by Prof. A. Campion and J. McEachen, associated with the Scottish foundry research organization at Kirkintilloch, Scotland. In this paper the relative merits of a number of core binders of the linseed oil type are discussed in the light of experiments made by the authors. It is pointed out in the paper that the best results in drying oil-sand cores are obtained from a temperature of 400 degrees Fahr., equivalent to 205 degrees Cent., or less. In most cases, it is stated, the most satisfactory results are obtained from a drying temperature of 300 to 350 degrees Fahr., equivalent to 150 to 175 degrees Cent. Cores dried at low temperatures for a relatively long time have a better skin and stronger edges than those subjected to a higher temperature for a shorter time.

The paper includes a table of the transverse, tensile and crushing strengths of cores made from 12 different binders. The test core was ½-inch square and 7½ inches long, tested between 6-inch centers, the two halves being subsequently broken on 3-inch centers. The tensile tests were made on cores of the standard cement briquette shape with necks 1 inch square. The table reveals great variation between the different binders, which from a commercial standpoint are supposed to be practically the same. The transverse strength of the 6-inch bars varied from 7.46 pounds to 84.0 pounds, and the tensile strengths from 11.2 to 70.5 pounds per square inch. The proportions were one of binder to 20 of sand. The cores were given practical foundry tests where they also showed great variation.

The paper was criticized by various speakers for its incompleteness, it being claimed that the number of tests made was insufficient to justify conclusions. Other speakers complained that the authors offered no information as to the composition or character of the various binders tested, and also stated that a ½-inch square bar has too small a cross section to give reliable results. Other speakers said the authors should be complimented for revealing the results of experiments which are admittedly incomplete, the data so far obtained being of great value.

Awarded Medal



W. H. SHERBURN

W. H. Sherburn, who was awarded the Oliver Stubbs medal for 1923 by the Institute of British Foundrymen, is an official of the Richmond Gas Stove Meter Co. Ltd., Grappenhall Works, Warrington. The Oliver Stubbs medal is awarded annually by the I. B. F. for distinctive services to the British foundry industry. Mr. Sherburn's efforts have lain mainly in the field of labor relations concerning which he is an expert. He has done a great deal to interest boys and others in the molders' trade and to develop in workmen the principles of true craftsmanship. He is the author of a paper entitled, "The Evolution of the Foundryman," which has been distributed in large numbers to foundry workers throughout Great Britain. He is a member of the general council of the Institute of British Foundrymen.

An American Viewpoint

One of the principal discussions was submitted by Henry M. Lane, Detroit, who reviewed the results of his own work on core binders. He said the problem is one of collodial chemistry, the action of the binder depending on that of interfering and supporting colloids. Mr. Lane explained the method he used to determine the true temperature of the center of a core during experiments on baking. These experiments, he said, showed that after a period of constant temperature, 212 degrees Fahr., while the water was being driven out, the temperature of the core rose gradually but did not fully reach the oven temperature even after 24 hours continuous heating. He said that cement testing machines when used for the tensile testing of cores must be fitted with special jaws made preferably of apple-wood, and adjusted to insure the briquette breaking in the neck.

Prefers Dune Sand

Instead of river or beach sand, which is extensively used in England, Mr. Lane expressed a preference for dune sand which has been driven and rolled about by the wind. He said that round sand forms quicker drying and stronger cores than sharp sand. He intimated it is unnecessary to dry core sand before mixing.

F. J. Cooke, Rudge-Littley Ltd., West Bromwich, referred to Mr. Lane's researches on oil binders, but expressed a preference for having the sand dried. He also said that a great improvement in results can be obtained by emulsifying oil and water, using the emulsion when making the core.

J. Cameron, Cameron & Roberton Ltd., Kirkintilloch, Scotland, called attention to the usefulness of such researches as those of the authors in making possible the use of local sands.

The two steel foundry papers were read at the Thursday morning session, June 14. In the absence of the authors, Major Bull's paper was read by H. Cole Estep and Mr. Melmoth's paper was presented by V. C. Faulkner.

In his paper Mr. Melmoth agrees with Major Bull on the question of sulphur, saying, "the influence of sulphur and phosphorus has been somewhat exaggerated. In the author's experience large numbers of intricate castings made from steel containing 0.06 to 0.08 per cent sulphur have not given the slightest difficulty. Also steel containing 0.10 per cent or more of phosphorus shows no signs of inferiority under the ordinary tests to which castings are subjected, the tensile and elongation capabilities of the metal being almost, if not quite, as good as that containing the merest trace of phosphorus." Mr. Melmoth also comments on the effect of aluminum and other factors along the same lines as Major Bull. In addition he

tells why British foundrymen prefer the basic-lined electric furnace, because "it can be used to refine materials high in sulphur and phosphorus," and because, "due attention to slag conditions produces compositions almost exactly to calculation, with what amounts to clockwork like regularity."

In discussing these two papers, Victor Stobie, Stobie Electric Steel Co., said: "We can assure Major Bull that we of the foundry trade in Great Britain well recognize that quantity production would have died a most early death had quality not played a sufficient role in such production. Only writers in the daily press can afford to disregard logic in the building up of kaleidoscopic wonderment, and the pictures such writers conjure up of the "press the button and the plant does the rest" type of industry in the United States is well qualified to make every one feel they are being misunderstood. In this country we are not all quite convinced that a steel casting of 0.055 per cent sulphur will ordinarily and always be equal in technical value to a casting of 0.015 per cent. One advantage of low sulphur lies in the fact that such castings can be properly treated in a shorter annealing time than the higher sulphur metal." Mr. Stobie also testified to the fluidity of electric steel and said it is notable for its quietness immediately after it is in the mold. A. Rhydderch, Hadfields Ltd., Sheffield, commented on the fluidity or life of converter steel, which cannot be explained, he said, by the heat generated from the reactions on the silicon and manganese. W. H. Poole, Keighley Laboratories, Keighley, Yorkshire, spoke of the usefulness of the acid-lined electric furnace. When the slag forms a film around the crystals of steel, he said, the fluidity is affected and under these conditions otherwise good metal freezes quickly. Such slag inclusions as there are should be globular.

Efforts which are being made in England to devise a suitable fluidity test for steel were alluded to by Dr. Percy Longmuir, director British Cast Iron Research association, Birmingham, who said that British foundrymen generally extended a warm welcome to R. A. Bull's paper. Casting temperature, Dr. Longmuir declared, has a distinct effect on the mechanical properties of the metal and should be adjusted to the size and section of the casting. In England, he also said, there is no special difference in the roof life between acid and basic lined open-hearth furnaces.

V. C. Faulkner, London, defended the use of aluminum saying that many of the difficulties arising from its employment are due to the fact that proper efforts are not made to get the aluminum actually into the steel. He also told of an aluminum-iron alloy now being made for grate bars containing 10 per cent of aluminum, which sweats out to the surface where it forms alumina and is said to increase the heat resisting qualities of the bars considerably.

For the first time an exchange paper also was presented on behalf of the French Foundrymen's association, entitled, "Notes on Carbon in Foundry Irons and Castings: Utility of Its Control and Practical Difficulties," by Professor Siegle, of Nancy university. In this paper the effects of silicon and carbon are discussed and more scientific classifications of foundry pig iron than those in general use are suggested, based on silicon and sulphur. The advisability of also taking carbon into account when buying pig iron is discussed by Professor Siegle. He confirms the fact, first brought to light by American investigators, that the addition of steel scrap to cupola charges does not necessarily lower the total carbon, owing to the absorption of carbon from the coke. In the absence of the author, this paper was read by R. Buchanan, foundry engineer, Birmingham, who in his discussion referred to the debt which foundrymen the world over owed to the work of the late Thomas D. West. F. J. Cook, discussing the paper, recommended the grading of pig iron more on a basis of carbon and silicon than fracture, but pointed out that iron does have certain qualities not dependent on chemical composition, the scientific basis of which may be the differences in solubility of the different kinds of carbon in iron. Professor Rheade of the Manchester College of Technology also referred to the fact that graphite differs in iron and that some kinds are much less readily soluble than others. The attendance at the meeting was unusually large and the entertainment features were complete. In addition to the inspection of plants and trips to various points of interest near Manchester, the annual banquet was held Wednesday evening, June 13, at the Midland hotel. A musical program was provided and addresses were made by W. Cundiff, lord mayor of Manchester; W. Clare Lees, president of the Manchester Chamber of Commerce; Oliver Stubbs, president of the Institute of British Foundrymen, and H. Cole Estep, representing American Foundrymen's association.

Joe Krizek and Lees Hall have established the Industrial Metal Melting Co., Baltimore, Md.

Producing Steel Castings--II

Methods of Adding Deoxidizers to Steel and the Influence of Aluminum Described —Details of the Operation of the Electric Furnace and of the Converter Process Given

BY R. A. BULL

MOST open-hearth foundrymen believe it is wise to establish a maximum proportion of the scrap produced in the foundry, to the total amount of scrap making up the furnace charge. The author's experience has indicated the advisability of prescribing a maximum percentage for such foundry scrap as used in acid and basic open-hearth operations; and has strongly suggested a relationship between objectionable red shortness and a large percentage of foundry scrap charged. The writer does not know of any conclusive research into this problem that has been made. Tests of the kind necessary to establish definite data regarding this problem are seldom undertaken because of possible costly results if it might be shown that many unsatisfactory steel castings are produced when excessive quantities of foundry scrap are used. The steel foundryman, who generally has a most practical mind, is apt to assume the possibility of trouble, when by so doing he is playing safe as regards quality, and is not appreciably adding to his melting or other costs in his regular practice.

So far as the author knows, there is no general agreement of opinion as to the maximum percentage of foundry scrap advisable to charge in open-hearth practice. Each foundryman has regulated it according to his own judgment, which is influenced by the nature of the work he ordinarily produces. Some plants have established the maximum limit at 45 per cent of the total metal charge, which, in the opinion of the author, is reasonable.

Recarburizer Not Desirable

In the United States, it is the opinion of many open-hearth melters, shared by eminent metallurgists, that it is desirable to use iron ore in reasonable quantity to secure a good boil in the bath. The behavior of the heat after a moderate ore addition, and the quality of the resulting metal as shown under physical test, seem to sustain this belief. It is generally thought that oxidation should not progress to the point where a relatively large amount of some recarburizer such as anthracite coal or coke is needed in the ladle. Experience of the melter with the particular furnace under his control is usually the best guide as to the exact maximum proportion of such recarburizer that can be safely employed for the production of first-class steel. The ore used for accelerating oxidation is high grade, and is frequently purchased to come within the following requirements:

	Per cent
Iron	not less than 55.0
Silica	not more than 10.0
Phosphorus	not more than 0.500
Sulphur	not more than 0.250

Barring the slightly increased percentages of manganese and silicon considered best to provide for finished basic open-hearth steel as compared with the acid metal, there is no essential difference in American practice regarding the manner of introducing the alloys containing these two important deoxidizing agents.

The ferromanganese is generally purchased on specifications calling for the following:

	Per cent
Manganese	not less than 78.00
Phosphorus	not more than 0.200
Sulphur	not more than 0.050

At this writing there is unfortunately considerable variation in the manganese content of ferromanganese, resulting sometimes in many determinations and great care on the part of the foundryman to sort out shipments containing varying amounts of the principal element.

The manganese alloy is added in the bath or in the ladle according to the judgment of the controlling metallurgist. Probably in most American steel foundries manganese additions are made cold in the ladle with the resulting minimum loss by oxidation of this element. Some metallurgists believe that better distribution of the manganese in the steel follows a bath addition. In the main an unproved conviction exists to this effect, as the controlling element of practice in some plants. The fact regarding the lesser quantity of manganese needed for ladle additions, is the regulating factor in other foundries. Investigations are in progress in certain foundries with which the author has close contact, to ascertain definitely the various factors such as relative oxidation loss, uniformity of distribution, and deoxidizing influence of manganese additions made to steel before and after tapping from the furnace.

The introduction of silicon in American open-hearth foundries for purposes of deoxidation, is nearly always made by means of 50 per cent ferrosilicon, introduced cold in the ladle just before tapping. This alloy is frequently purchased to contain between 48 and 55 per cent silicon, with no shipment to vary more than 2 per cent. No limitations are imposed for phosphorus and sulphur.

Open-hearth foundries sometimes use an alloy containing approximately 12 per cent of silicon introduced in pig form and containing a large iron content. It is generally specified that this alloy shall contain not more than 100 per cent phosphorus or more than 0.050 per cent sulphur. This pig silicon alloy when used, is generally for the purpose of adding carbon or temperature, or both; and its influence on the final silicon content is slight, because of considerable time required to melt it, during which period oxidation of the silicon occurs, and indeed is generally desired.

Aluminum as a Deoxidizer

Among the important factors in open-hearth and other steels is the influence of aluminum, probably used in every American steel foundry as a final deoxidizer, to supplement the useful service performed by manganese and silicon. The author's sources of information indicate that in most cases an amount of aluminum is added to the steel in foundry practice in the United States, varying from 4 ounces to 16 ounces per net ton of metal charged. The use of this element has been properly regarded with suspicion. No published data have come to the attention of the writer showing conclusively the influence on physical properties in steel castings, of alminum additions in the steel. Tests made with which the author is familiar apparently indicate little if any bad results on physical properties when aluminum additions represent less than 4 ounces per ton of charge. He believes the effect of an aluminum addition amounting to as much as 12 ounces per ton is distinctly harmful in the influence on ductility. It seems altogether probable that investigations now

in progress will show little or no bad influence of the small quantity of aluminum advisable to use as a final precaution when pouring steel into sand molds. Also that it will be ascertained that a definite low limit in quantity per ton should be established for daily practice, beyond which we may safely assume a marked decrease in the percentage of reduction of area, an appreciable lessening of the percentage of elongation, and a slight, harmful influence on the yield point and ultimate strength, of the specimen used for tensile testing. Investigations which point in the directions indicated are being conducted by several companies with which the author is associated.

Conceding in a general way the probable bad influence of aluminum additions of appreciable amount, many American steel foundries have experimented with the use of other elements than aluminum, and compounds containing elements, having an affinity for oxygen—all for the purpose of reducing or eliminating the customary aluminum addition. Experimental substitutions have not been successful. A few foundries believe they secure better results by the use of some compounds, generally containing silicon, simultaneously with the addition of a small amount of aluminum. A great deal of knowledge is yet to be gained regarding this important detail of American steel foundry practice. Naturally it has more significance for basic than for acid founders. Naturally too, this factor is of particular importance to open-hearth practice as compared with electric practice, because of the greater opportunity in the open hearth for oxidation. Whatever the process employed, it may be conceded that the industry as a whole has not been able to bring about all the deoxidation desired by the use of generally useful elements such as manganese and silicon, important as they are in such reactions.

Aluminum Wire Used

In open-hearth practice the aluminum is introduced in several ways. Rarely is it added in the bath. Generally it is placed in the bottom of the ladle as it receives the metal from the furnace spout. When this is done the aluminum may be in pig form or in the form of *shot* of irregular proportions. Supplementing the introduction of the aluminum either in the bath or in the ladle, it is common practice in open-hearth foundries regularly or periodically to feed aluminum wire, usually about ⅜ inch in diameter, into the stream of metal as it enters the mold. Some open-hearth foundries make this supplementary aluminum addition only when the metal indicates a tendency toward *wildness*. In certain basic open-hearth foundries the use of the aluminum wire has been resorted to invariably near the end of the pouring operation, when by reason of the closer contact of the metal being poured, with the overlying slag in the ladle, the reduced percentages of manganese and silicon in the steel of the last part of the heat can be safely assumed.*

Acid Lining Predominant

Before discussing details of steelmaking in electric furnaces, it is appropriate to refer to the factors that have recently resulted in a relatively small number of units making basic electric steel for castings. The percentage of such basic electric furnaces now being operated is so small that the author feels justified in confining his descriptions of electric steel melting, as now conducted, to that performed within an acid lining. Preliminary to these discussions it should be explained that American practice naturally followed that developed in Europe in first employing basic linings.

A trial for a reasonable period convinced many of the pioneers in electric furnace operation for foundry use in the United States that a basic slag and the super-refinement which it permits, impose a serious handicap on lining and roof, through the thin nature of the typical slag, and the prolonged maintenance of a very high temperature, to which the best obtainable refractories are exposed. Another factor of real consequence was the increased time required for making a heat, and the burden that it imposed on a busy shop, as compared with the satisfactory pouring schedules permitted by converter operations. It must be remembered that many electric steel furnaces in American foundries had superseded converters, the use of which was well known to many seeking a more satisfactory melting unit.

About the time when excessive damage to refractories, and retarded pouring operations with their resulting handicap to molding schedules, demanded the serious consideration of the American electric furnace pioneers in the foundry, a movement was instituted in the States to critically investigate the actual effects in steel of phosphorus and sulphur. The satisfactory use for ordnance purposes of considerable steel made abroad, containing relatively high percentages of phosphorus and sulphur had come to the attention of many American metallurgists. It was felt by most of these, who were not biased, that the limitations ordinarily imposed for sulphur content in steel are the result of supposition which is no compliment to the metallurgical profession. The conviction grew that a steel which carries a reasonably high percentage of sulphur performs as satisfactorily in service as one whose sulphur content is extremely low. Applied to steel casting manufacture, the percentage of sulphur has another aspect, related to red-shortness. This was generally felt to be purely a manufacturing and not a service problem. The prevailing opinion in the steel casting industry today is that a steel casting whose sulphur content is around 0.015 per cent will probably give no more satisfactory results under service conditions of the ordinary exacting kind, than a similar casting which has a sulphur content of 0.055 per cent if all other conditions are equal.

The desire to dispel supposition and to establish fact resulted in the organization of a joint committee on the investigation of phosphorus and sulphur in steel. The personnel of this committee includes representatives of all of the important engineering and technical associations whose interests ought to be centered in such a research. Appropriately, the American Foundrymen's association has its delegated representative on this joint committee. Definite co-operative steps thus taken to establish reliable data seemed to greatly strengthen the confidence of many steelmakers in metal containing normal percentages of phosphorus and sulphur. The result was less importance assigned generally to the admitted superiority of the basic electric furnace as compared with the acid, in delivering a product having a low content both of phosphorus and sulphur.

Scrap Easily Obtained

Experiments in conversion of electric furnaces from basic to acid were extremely satisfactory, came promptly to the notice of the industry at large, and were speedily followed by similar tests with subsequent definite decisions to employ acid linings. In the United States it is not difficult in most localities to obtain, at reasonable prices, scrap of suitable composition, which, when charged into the acid electric furnace without any pig iron, but with a normal percentage of the foundry scrap locally produced, yields a metal well within the limits for phosphorus and sulphur in current specifications, and therefore below the percentages generally believed to be harmful to steel in service.

The preliminary report of the joint committee on the investigation of phosphorus and sulphur in steel, published in 1922, dealing with sulphur in certain steels, has in no sense tended to increase the prejudice against that element.*

THE FOUNDRY, September, 1909, pages 33-34, "Analysis of the Last Part of a Basic Open-Hearth Heat," by R. A. Bull.

Proceedings of the American Society for Testing Materials, Vol. 22, Part I, pages 91 to 130 inclusive, by the joint committee on effect of sulphur on rivet steel.

THE FOUNDRY DATA SHEET, JULY 15, 1923
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

ALLOYS OF ALUMINUM

Aluminum-Copper-Nickel-Magnesium Alloys

Alloys of aluminum with nickel, copper and magnesium are found to retain their strength at a higher temperature than any other wrought alloys of aluminum, and exhibit a marked resistance to corrosion, even when in contact with sea water. A typical alloy of this group is the following:

	Per cent
Aluminum	92.50
Copper	4.00
Nickel	2.00
Magnesium	1.50

Its properties in the condition of a sand-cast bar 1 inch in diameter are:

Yield Point, lbs., per sq. in.	Ultimate Strength, lbs., per sq.in.	Elongation, % in 2 in.
18,700	25,000	1.5

Chill-Cast Bar:

Yield Point, lbs., per sq. in.	Ultimate Strength, lbs., per sq. in.	Elongation, % in 2 in.
20,600	28,500	1.5

Aluminum-Copper-Manganese Alloys

The addition of a small amount of manganese has been found to improve the alloys of aluminum with copper alone, and when it is not desirable to further harden such alloys, the manganese should replace a percentage of the copper, thus in the case of alloys

Presented by W. Rosenhain in the course of a lecture before the Royal Society of Arts, April, 1920.

(*Concluded on Data Sheet No.* 486)

ALLOYS OF ALUMINUM

(*Concluded from Data Sheet No.* 485)

containing 4 per cent of copper, 1 per cent of copper may be replaced with one per cent of manganese, resulting in the following alloy:

	Per cent
Aluminum	96.00
Copper	3.00
Manganese	1.00

The mechanical properties of this alloy are as follows:

Sand Cast Rod:

Yield Point, lbs., per sq. in.	Ultimate Strength, lbs., per sq. in.	Elongation, % in 2 in.
13,440	16,800	.....

Chill Cast Rod:

Yield Point, lbs.,per sq. in.	Ultimate Strength, lbs., per sq. in.	Elongation, % in 2 in.
16,352	27,100	13.0

Rolled Rod:

Yield Point, lbs., per sq. in.	Ultimate Strength, lbs., per sq. in.	Elongation, % in 2 in.
28,672	36,960	15

Tests also show that the alloy containing a small amount of manganese has increased power of resisting corrosion.

Alloy—Aluminum, 96 per cent; Copper, 4 per cent

Sand-Cast Rod, 1-inch diameter:

Yield Point, lbs., per sq. in.	Ultimate Strength, lbs., per sq. in.	Elongation, % in 2 in.
10,976	16,800	5.0

Chill-Cast Rod, 1-inch diameter:

Yield Point, lbs., per sq. in.	Ultimate Strength, lbs., per sq. in.	Elongation, % in 2 in.
12,096	21,504	10.5

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PHILADELPHIA, U.S.A. May 25, 1923.

THE FOUNDRY,
Penton Building,
Cleveland, Ohio.

Gentlemen:

The fact that we have been consistent advertisers in THE FOUNDRY for some years is conclusive evidence of what we think of that publication as a publicity medium.

A large portion of our products are called for by the foundry trade and it is but natural and logical we should look to THE FOUNDRY to convey our message to that class of grinding wheel user.

Yours very truly,

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Asst. Sales Manager.

It was unfortunate for the desired early progress in America of electric steel casting production that certain exploiters of the electric furnace combined with their selling arguments the claim that this melting unit was one that could be depended upon to regularly produce good metal simply by switching the power on a charge of ferrous scrap. Some of these overzealous persons declared the electric furnace to be adaptable to all classes of steel castings manufactured, and to be in effect a veritable panacea for most of the troubles common to steelmaking in the foundry. In some instances it required sad experience to demonstrate otherwise. Foundrymen learned that good judgment and scrupulous care are required of a successful electric steel melter. As the natural result of exaggerated claims, and careless and inexperienced manipulation, some very inferior electric steel was made in American foundries before the fact dawned on credulous individuals that something more than *turning on the juice* is necessary. As a people, perhaps we are inclined to believe what we are told, and often to listen for what we have been wishing to hear, in the idealism which undoubtedly influences even our industrial activities. This has much to do with our ready disposition to experiment with something new. To offset this, happily, we seem to learn with reasonable quickness from our experience, and thereby to discount the fanciful stories that originally made a vivid impression. Americans in and out of the foundry are not perpetually sold by an idea that does not successfully bear the strain of hard experience. Once disillusioned, they go seriously into the business of digging their way out. Accordingly, by stages, steel foundrymen in the United States learned how to make good steel in the electric furnace, and where to economically employ this method of melting.

The degree of education that has been attained by American foundrymen in electric melting is of course variable. Information yet to be learned by all engaged in the art is considerable. Many important facts have been established and have been the means of regulating certain major details of practice with slight variations.

Study Furnace Design

The furnace design itself naturally has received much study by metallurgists and by electrical engineers. Reference in this paper will be confined to the arc type of furnace because of the practical unanimity of opinion favoring it in the United States as compared with the induction furnace. Opinions naturally differ regarding the kind of arc furnace found best to employ. It is not the proper function of the writer to advocate the use of any particular make of furnace, nor indeed is it scientific for any one to form a positive opinion without opportunity to definitely ascertain the results achieved from different types of furnaces.

Three Ton Preferred

The electric furnace as commonly found in American steel foundries has an electrically tilted circular shell, and has three electrodes piercing the roof. Preference for the material in these electrodes is about equally divided as between graphite and carbon. The use of economizers for the electrodes in America is uncommon. The writer does not know of any steel foundry in the United States where the electrodes are made and baked from the heat produced by the furnace itself, as is the case to some extent in Europe. As indicated previously, the lining of the typical furnace is an acid one and is generally formed from silica brick or from ganister rammed into place. Most of the roofs are of silica brick or a combination of these and special silica shapes, through which the electrodes pass.

A rated capacity of three net tons to represent the metal-charge is most favored in the United States for foundry operations. This is due largely to the nature of the work for which electric steel is most suitable. A factor of importance is that of the time required for making a heat, in relation to the desirability of having the metal delivered without long intervals to the molding floor. American foundrymen realize the economy of a unit of fairly large melting capacity, when considered solely from the standpoint of fuel consumed. In the selection of furnaces varying from 1 to 6 tons in capacity the matter of power consumption therefore has been given careful consideration. Many of those who formerly installed furnaces rated below 2 tons and above 4 tons would probably today prefer 3-ton units, in the light of their experience and that others with whom they have exchanged data.

In the industry with which we are concerned there may be said to be practically no charging of molten metal. Generally the scrap is shoveled into the charging door just as transported from the stockyard. In some cases chutes are constructed into which the charges are loaded. The procedure is to introduce the open end of this chute into the doorway and to lift the other end by means of a crane so as to slide the scrap charge into the bath, at a considerable saving of time in charging. In a small proportion of furnaces the furnace roof is of the tilting type, intended not only for the quick introduction of the charge but the preheating of the same, generally by means of fuel-oil in a supplementary vessel. The charge, red hot but not melted, is dumped into the furnace with resulting economy in power consumption, and a lessening of melting time required in the furnace itself.

There are rather wide varieties of voltages and power in-puts for which auxiliary electrical equipment is provided, in electric steel foundries in the United States. While many transformers installed in the pioneering days were of inadequate proportions and unsuitable design for fast work in melting and for flexibility in voltage control, recent opinion seems to favor a fairly high voltage (from 140 to 180 volts) in melting down, and a lower voltage (around 120 to 130 volts) for the final operation. Some foundrymen recently have provided transformers permitting by the use of many taps a flexible arrangement as to voltage. This was done partly to ascertain what voltages are best to employ after thoroughly trying those covered by a wide range.

With cold charges, 3-ton acid furnaces will frequently deliver as the result of a full charge, under conditions of normal in-put and voltage, hot low-carbon steel suitable for running sections of ⅛-inch, on a power consumption that will average about 650 kilowatt hours per net ton of charge. Under similar conditions when the charge is preheated but not actually melted, such a furnace will probably average 550 kilowatt hours per net ton of charge. A factor which has much to do with such power consumption, and one which is of widely differing nature in the United States, is that of tightly sealed openings for charging and tapping. When these are water cooled to prevent warping and resulting air leakage, the thermal efficiency of the furnace is greatly increased. Those who have installed such water cooling devices feel well repaid for having done so. Probably another advantage lies in the superiority of the metal thus produced through the much more effective control in the admission of oxygen to the bath

No Pig in Charge

It is almost the universal practice in acid steel melting in American foundries using the electric furnace to carry no pig iron in the charge, except when fairly high carbon steel is to be made. Even then, in many cases, carbon frequently is supplied by immersing electrodes in the bath or by adding broken portions of electrodes carefully weighed. If the theory held by many open-hearth melters is correct, that a certain amount of carbon contained in the original metallic charge is desirable,

one may ask if the same condition does not apply to electric melting; and if not, what reason exists for the difference. The author does not presume to give the correct explanation. The continual presence of carbon vapor emanating from the ends of the electrodes may have something to do with this.

The addition of silicon to the metal in an acid electric furnace in the United States is generally by means of cold 50 per cent ferrosilicon, introduced into the bath a few minutes before tapping. There are some foundries where it is believed better results are obtained by reduction of the silicon from the silica, for which purpose the scattering of anthracite coal over the slag seems to be an aid in the reaction on the lining produced by the slag. Floor tests poured at frequent intervals before tapping regulate the quantity of ferrosilicon additions.

Must Not Show Pin Holes

There is nothing that would probably be significant to British foundrymen, in a study of American electric furnace practice, so far as it relates to manganese additions for that particular practice. Manganese additions, as in open-hearth practice, are in the form of 80 per cent ferromanganese, are usually added cold, generally in the large ladle, and in a minority of cases in the bath. Comments regarding such additions, made in the section devoted to open-hearth melting apply with equal force to the practice now being considered.

Either as the metal is tapped from the furnace into the large ladle, or as it is shanked from the large ladle to pots for hand pouring, electric steel receives aluminum additions of rather varying amounts according to the ideas held by individuals; also according to the nature of the castings being made. Such steel used for castings to be throughly machined which must show not the slightest evidence of *pin holes*, as small blow holes are termed, generally receives a slightly larger aluminum addition than does other steel. The author believes this safeguard has been employed often without due regard for physical properties. Further comments regarding aluminum additions are unnecessary in view of previous remarks on this subject as related to open-hearth practice. It appropriately may be stated that the author's objection to high aluminum additions applies irrespective of the method used for melting.

Producing metal by means of the electric arc for steel castings lends itself to a large variety of flexible details according to the ideas of the designer, the judgment of the foundrymen, the class of work produced, and the local conditions. It is, at 15 years of age, decidedly the youngest child of the American steel casting industry. Its rapid development has attracted special interest at home. Therefore, it has been believed by the author that British foundrymen would desire rather extended explanation of electric steel melting as conducted in foundries in the United States.

As indicated previously, American converter operation is restricted to that adapted to an acid lining. There are no low-phosphorus iron ores of commercial significance in the United States which when converted into pig iron provide a low enough silicon content to make basic converter operation satisfactory. In American steel foundries the lining is generally formed of ganister bonded with clay, sometimes mixed with a percentage of silica sand. Occasionally blocks made from mica schist have been used. The vessel employed for casting shops is ordinarily of about 2 tons capacity and is almost invariably side blown. The blast pressure averages close to four pounds. Prevailing opinion in the United States has been that less danger from excessive oxidation of the steel attends the use of side-blown as compared with bottom-blown converters.

Converter operation presents no novelty to British foundrymen. Therefore, reference to the conversion that takes place in this vessel need not be elaborate. However, the continued extensive use of the converter abroad in foundries, suggests the supplying of certain information pertinent to American practice for the interest comparative data may have.

In the making of low-carbon converter steel for castings, pig iron has been used averaging about 2.0 per cent carbon, 2.0 per cent silicon and 0.50 per cent manganese. Several such irons contain small percentages of copper, resulting from the nature of the ore used for smelting low-phosphorus pig. The percentages of phosphorus and sulphur in such iron are each under 0.03 per cent. In American converter foundries, the proportion of pig iron to the total cupola metal charge has ranged between 20 per cent and 50 per cent. To melt this it has been the practice of converter operators to purchase coke having a sulphur content not exceeding 1.0 per cent. In 1917 and 1918 it was difficult to secure such low-sulphur coke suitable for converter steel foundry operations The scarcity and resulting purchase price of this fuel had much to do with decisions to experiment with electric furnaces.

Melting Loss High

It has been generally found that a melting loss from combined cupola and converter operation of 16 to 18 per cent is typical among the casting plants that have used the converter. This, of course, was an additional factor of consequence during the war when it was difficult to secure low-phosphorus pig iron and scrap.

In some converter foundries it has been customary to use about 18 pounds of 80 per cent ferromanganese per net ton of the metal charge calculated before deducting the oxidation loss. An amount of 50 per cent ferrosilicon calculated in the same manner on the basis of 8 to 10 pounds per net ton has been similarly used. Details of converter practice in many respects have differed rather widely; likewise the quality of the metal that has been produced. Irrespective of these varying details, an average period of time during which the metal has been subjected to the blast in the converter has been close to 20 minutes. From the standpoint of almost continuous delivery of the steel, especially desirable in the making of small steel castings, the converter admittedly is an ideal unit. Another important factor in this respect is that of the high temperature attained.

Operation Required Skill

In the hands of the most skillful melters, the converter in American foundries has delivered steel of a satisfactory quality. Like the electric furnace, it has lent itself admirably to intermittent operations not commercially possible with an open-hearth furnace. The converter has the additional advantage of a low installation cost which has made it appeal to many foundry concerns having a limited capital. In the history of American steel melting for foundry operations, the converter secured a highly useful place. There grew into being, as converter steel foundries became more numerous, a class of converter *blowers* or melters, many of whom thoroughly understood their business. These had much to do with the high quality of some converter steel made, which proved to be a product superior to some of the first metal produced in electric furnaces that were erroneously claimed by certain enthusiasts to require no particular care in operation.

Probably in those districts of the United States where local conditions are distinctly favorable as regards special pig iron and other raw materials, and where power cost may continue to be excessive, the converter will be maintained as the preferred steel melting unit for the classes of castings for which it has been well adapted. Among these, as in the case of the elecric furnace, is the field of thin sections and alloy castings, including those made with a high percentage of manganese. Recently, basic electric furnace installations have superseded the converters.

Bill Discusses Apprentice Training

BY PAT DWYER

AFTER you have been acquainted with a person for a time you can foretell with a reasonable degree of accuracy just what he or she will do or say under a given set of circumstances. On second thought, perhaps that statement should be amended by omitting any reference to the feminine gender. It is true that every rule has its exceptions, but in this case the exceptions are so numerous, it is idle to talk about a rule. This characteristic of human nature is so universally recognized that gifted young men who draw the comic strips in the papers take advantage of it. Therefore, you know instinctively that whenever you see one character offer another a light for his cigar, the same cigar is due to explode in the extreme right hand sketch. I never have decided whether the artist under estimated his own or the reader's intelligence. The picture shows the victim registering the utmost amazement, his mouth and eyes are stretched to their utmost capacity, usually his legs are tied in a knot and his arms are thrown into a shape that never was contemplated by his Creator. Naturally, you would think that any ordinary human being above the age of two years would gain an impression from the picture showing a cloud of smoke and sparks that an explosion had taken place. The artist takes no chances. He prints the letters *BANG* in the center of wreck and that disposes of any possible argument on the subject.

When you see the word automobile near the front of a paragraph in the funny column, you do not have to read the remainder of the paragraph to find out whether the machine is an imported or domestic model. In fact practically all the stories are variations of one that was set afloat to celebrate the completion of the first hundred thousand and you do not need to sport a long gray beard to remember back that far. The driver of a heavy, imported foreign car was feeling his way gingerly around a hair pin turn on a mountain road when he was hailed by the unfortunate driver of a small popular priced car who had driven not wisely but too well around the same turn some time previously. The second man had succeeded in righting the machine and had it sitting pretty on all four wheels, but for some reason it was balky and refused to start. He had exhausted his patience and his stock of ordinary profanity and was drawing freely and extemporaneously on his imagination when the driver of the big car pulled up alongside.

At this point the story shows the effect of what passed for humor in an earlier generation and is reminiscent of the Arkansas traveller. The driver of the small car (name deleted by censor) poured forth a sorrowful tale and concluded by asking the other man if he knew anything about a—well, the car which had come to grief. The driver of the big car laughed.

KIND WORDS ARE SUCH A HELP

"Har, har," said he in regular melodrama style. "No," said he, "I don't. All I know about them things is a lot of funny stories. Har, har, goo' bye!"

What I had in mind when I started this little essay was an incident that happened the other day. I have known Bill so long and so intimately that I know instinctively by the manner in which he mounts the veranda steps whether he has something interesting to disclose, or has just come over to smoke the pipe of peace. Hence, when he hopped nimbly up the steps the other night I pointed to a chair and asked him politely what he had on his mind, if anything besides his hat

"Coincidences," said Bill in his best and most formal manner, "are wonderful things. Recently I read an interesting article on the part the negro is taking in our northern industrial life and the manner in which the insatiable demand for labor, particularly in the iron and steel industry is serving as a powerful magnet in drawing Uncle Tom and his descendants from away down south in the land of cotton. Today I had a letter from an old friend in Philadelphia touching somewhat on the same subject. He had particular reference to colored labor in the foundry and enclosed a sheet purporting to show the typical attitude of these sons of Ham after they had remained long enough on the job to qualify as molders."

He reached into one of his numerous pockets and produced the following document, entitled:

Ah's a Moldeh

'at Isaac Jones suttinly am one biggity niggah. Yest'day while Ah wus a-sweepin' de chu'ch steps he comes prancin' along an' he says: "lo fellah," he says an' Ah says: "Who's a fellah?" An' he says: "You, Niggah!" "An' Ah says: "Whut am you?" An' he says:

"Ah's a Moldeh!"

'at niggah has mo' clo's on as evah Ah see an' he wus a-smokin' one o' dese yer big quatah seegahs an' he puts a dollah in de plate las' Sunday an' afteh chu'ch tonight, Ah says: "Mistah Jones," Ah says, "How come you spo'tes all 'em clo'es an' 'at hunk o' ice in yo tie an' 'em yallah shoes?" An' he says:

"Ah's a Moldeh!"

* * *

"How come?" Ah says, "What am a moldeh?" An' he says: "A moldeh am a mee-chanic whut makes t'ings out o' i'on an' fudemo a mee-chanic am a man whose woman don't take in no washin'. Ain't no moldehs whut ain't mee-chanics an'

Ah's a Moldeh!"

* * *

"Yaas suh, a white man makes ma patt'ns an' han's 'em to me mighty polite an' carefull like an' mah helpah puts 'em in a box an' sif's san' on 'em an' we rams 'at san' in, BIFF!BAM! An' we tromps it down, WOOF! WOOF! An' 'en Ah draws 'at patt'n slick and puty. Ain't no man kin draw a patt'n 'cept a moldeh an'

Ah's a Moldeh!"

* * *

"Ah puts up twelve flasts eve'y day an' fills mah floah a bustin', an' when Ah's done, a white man brings me a ladle o' i'on, sizzlin' an' smokin', an' Ah says: 'Come to yo' papa, li'l Joe, you is mah baby.' An' Ah grabs 'at ladle an' po's 'at i'on an' she goes WHOOSH! in 'at hole, hot dam! an' de spa'ks fly, but Ah ain't skee'd.

Ah's a Moldeh!"

* * *

"Whut does y'all gi:?" Ah says. An' he says: 'Eight bones.' " "A week?" Ah says. "A day," he says. "Mah Gawd" Ah says. "Any chance foh me?"An' he says: "Ah d'no, you is a big husky niggah, but you ain't had no edjcation lak Ah has. Yo' is only a chu'ch janitah an'

Ah's a Moldeh!"

* * *

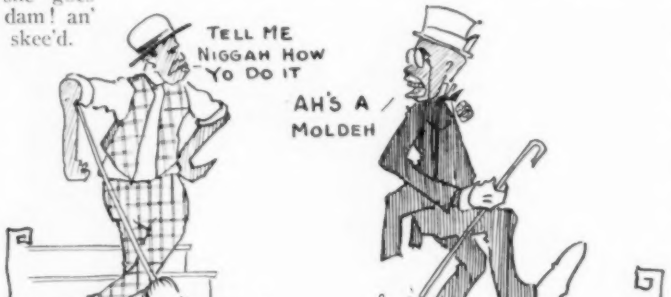
"Takes a might sma't man" he says "foh to be a mee-chanic an' a mighty sma'teh one fo' to be a moldeh. Ain't many niggahs whut am mee-chanics, ain't many niggahs whut have a white man to wait on' em. If yo' is a-pinin' to show yo' stren'th, yo' bettah be a bo'leh makeh. Yo' would be a good bo'leh makeh, but yo' ain't got no haid fo' to be a moldeh. Yo' ain't sma'ht lak me.

Ah's a Moldeh!"

"I have heard a great many discussions recently," said Bill, "on the subject of apprentice training. I also have heard many foundrymen bewailing the fact that no boys are entering the industry and as a result, in all probability, the foundry business automatically will cease in a few years and take its place in the limbo of forgotten things with the great auk and the dodo. Evidently these people are overlooking the great mine right to their hand, the harvest ready for the reaper. Need I say, dear brethern I have reference to the possibilities presented by the colored race to bridge this gap in the ranks of industry.

"In the olden days no trouble was experienced in securing a sufficient quota of apprentices. In fact the supply was so greatly in excess of the demand the molder's union insisted on limiting the number to one for every eight journeymen employed. It was felt that the industry would not absorb any greater proportion. Later, in deference to a practically nation wide demand on the part of foundry owners the proportion was increased to one to five. Even at that figure boys readily were available.

"Two main factors are responsible for the scarcity of boys in the foundry. One is the molding machine and the other is conditions rising out of the late war. So many jobs at comparatively high wages went begging during the war period that boys and young men in the class from which foundry apprentices usually are recruited, developed an inflated idea of their own value and regarded the modest wage offered in the foundry as entirely beneath their notice. They could not see anything alluring about spending four hot, heavy years in a foundry to qualify for a wage approximately 50 and certainly not more than 75 per cent of that paid in the building trades.

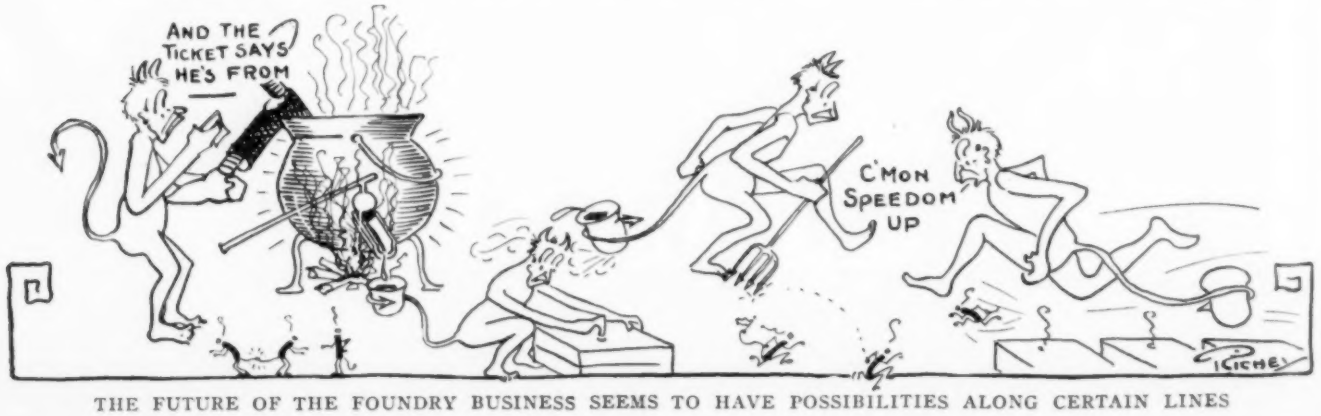


EIGHT BONES A DAY AND ALL NIGHT IN WHICH TO SPEND THEM

"The molding machine has been the greatest single factor in sterilizing the industry so far as the production of apprentices is concerned. So long as the industry was dependent on a supply of molders trained in the usual manner through a four years apprenticeship, effort was made to secure and train them. The business expanded steadily and rapidly, keeping pace with the growth and expansion of the country and an increasingly larger number of molders were required from year to year. Then the molding machine arrived making two molds grow where only one grew before and the demand for molders dropped in proportion. This despite the fact that the output of castings steadily increased.

"Honest effort was made in many foundries to teach boys the trade in a proper and comprehensive manner, at least up to the limit imposed by shop conditions. However, there is no disguising the fact that in many shops the boy was regarded simply as a cheap form of labor and exploited accordingly. He was given the simple jobs, the plain work, the repetition orders, work which he could be taught how to do in a short time and then was kept on that kind of work indefinitely. Handled in that manner he was a profitable feature and in addition he required little or no supervision.

"The mo'ding machine changed operating conditions along the foregoing lines. Foundrymen discovered that ordinary labor could be broken in on molding machines in a comparatively short time to turn out a great many more molds than even the most skilled molder work-



THE FUTURE OF THE FOUNDRY BUSINESS SEEMS TO HAVE POSSIBILITIES ALONG CERTAIN LINES

ing under ordinary conditions. This of course did not apply to the ordinary jobbing shop or the shop engaged principally in the production of heavy machinery. However, this condition did obtain in practically all foundries engaged in what is known for want of a better word, as quantity production. The molding force in all these shops is recruited from the ranks of unskilled labor and for that reason the supply of skilled all around molders has kept pace with the demand even though few apprentices are learning the trade.

"However, that condition cannot continue indefinitely. There is a tradition in the foundry that molders never die, but the statement probably is an exaggeration. The present generation will throw up the shovel for keeps one of these fine days and then who is going to take their place? Production shops are manned by semiskilled men who have been put through an intensive course of training along an exceedingly limited line. Members of the supervisory force have had a broad foundry training and are competent to instruct the various workmen in their respective duties and also are competent to lay out the work to the best advantage within the scope of the available mechanical equipment. These men have been recruited from the ranks of the all around molders and like the others who remained in the jobbing shop they eventually will join their brethern where the wicked cease to trouble and the weary are at rest.

"If every feature progressed in the same ratio one could prophesy with a fair degree of accuracy and with a reasonable chance of seeing his prophecy fulfilled, that the foundry business, so far as providing a supply of molders is concerned will arrive at an acute stage in possibly ten and at the outside, twenty years. I am inclined to take a more optimistic view. All the factors involved do not progress at the same rate and the foundry business, like any other may develop radical changes in methods and processes at any time.

"One of our famous statesmen, Patrick Henry I believe, once said that the only satisfactory way to judge the future is by the past. My memory does not extend back anywhere like a hundred years, but I never heard or read of a period in the industrial development of the world when progress was halted to any appreciable extent on account of lack of men to carry on the work. In fact the contrary usually has been the case. Inventive genius either has kept ahead of demand or has developed a method for taking care of congestion before affairs became hopelessly deadlocked.

"By the time transportation had become a serious problem, Stephenson invented the locomotive and provided a means for distributing commodities over an area never contemplated by a people accustomed to transporting loads by horse drawn vehicles. James Watt invented a hoisting engine that increased the capacity of coal mines to an incalculable degree and furnished fuel for thousands of industries. The application of steam to ocean going vessels brought the great markets within reach of each other and developed a world-wide commerce. It has developed the natural resources of otherwise unknown lands. It has broken down barriers of caste and tradition and has placed modern conveniences, food, clothing and a thousand and one articles once regarded as luxuries within the reach of the great mass of the people.

"Eli Whitney invented a simple contrivance for removing the seeds from picked cotton. Within a short time the price of cotton cloth was reduced from $1.00 to a few cents a yard. In a few years the Southern states had progressed from a region producing a few cotton bales a year to the greatest cotton producing and exporting country in the world. The cotton gin was responsible for the textile industry of New England and for a similar industry in the South which bids fair one day to outrank its northern progenitor. Its influence was felt across the Atlantic and where formerly a few spindles were in operation in England and in continental Europe, today millions of looms and spindles in these countries are whirling day and night turning out an endless sheet of cotton cloth."

"I don't see any particular reason," I said, "for going rambling all over the world in support of any contention, however meritorious. Laying aside for the moment your optimistic supposition that in a short time some inventive genius will develop a method of making castings, as simple in operation as the method by which a locomotive engineer can move a 1000-ton load by opening a valve that admits steam to the cylinders, I should like to know what you meant by an earlier statement to the effect that colored labor should be utilized more freely in the foundry."

"Quite simple, me lad," said Bill, "formerly the American boy was glad to learn a trade. The young journeyman was proud of his skill and the older men rather prided themselves on the many unwritten trade secrets stored away in their wise old heads. So long as this sentiment prevailed boys were willing to learn the trade of molding. Today, all this is changed. The worldwise and cynical youth knows a hundred easier ways of making a living than by going into a foundry. Appeal directed to his desire to acquire skill, knowledge or the pride of craftsmanship makes no impression on one of these wise ones.

"According to the document which I presented a few minutes ago these features appeal to the negro in a marked degree and therefore that is the field in which recruiting will bring results. When you come to consider the situation it seems logical that a black man should work at a black trade. I never quite could see why it was considered logical to place black men picking white cotton and at the same time placing white men at a job where they emerged at the close of the day looking like chimney sweeps or like the body guard of that famous personage equipped with cloven hoofs and a tail who is credited with maintaining a somewhat extensive furnace designed for casting and other purposes."

Making Small Cores

Question—We have undertaken to fill on order for castings in which some of the cores only measure ⅛-inch diameter. We have on hand common building sand, flour, rosin, linseed oil and linoil. Can we make the cores from this material?

Answer—(1) The statement that a core is ⅛-inch in diameter is a rather indefinite foundation on which to base an opinion. The core may be 12 inches long or it may be only ½ inch. It may be a straight core or it may be any one of a hundred crooked shapes. Obviously a method that might prove satisfactory for one well might be totally unfitted for another. In many cases foundrymen overlook the fact that the most satisfactory method of placing certain small holes in a casting is to drill them. Occasionally where it is not essential that the hole should be perfectly circular in cross section or absolutely straight and true in other dimensions a satisfactory core may be prepared by dipping a wire into liquid core binder and then rolling it in some fine sand. The wire with the adhering sand is dried in the oven in the usual manner and then placed in the mold. After the casting is poured the wire may be extracted followed by the sand. If the core is to be of an irregular shape a corebox in two halves will have to be provided. The two halves are filled with sand independently of each other, then brought together to form the whole core after which the corebox is removed. A fine grade of sand bonded with a liquid core binder will work satisfactorily.

W. R. Hans has been made district manager in charge of the offices of the Whiting Corp., Grindle Fuel Equipment Co., and Swenson Evaporator Co., Harvey, Ill., associated industries, with offices at 1702 Jefferson County Bank building, Birmingham, Ala.

Casting Brass and Bronze

Copper Oxidized in Metal Treated with Deoxidizers Which Reduce the Copper Forming Other Oxides—Carbon Monoxide Gas Protects the Metal from Oxidation—Zinc an Active Deoxidizer

BY CHARLES VICKERS

IT IS PROBABLE that more trouble is experienced with casting the nonferrous alloys than with the ferrous metals, such as the various cast irons and steel, because of the multiplicity of nonferrous alloys in use, and the wide divergence in their casting characteristics. Some nonferrous alloys are quite simple to make into castings, others are so difficult that few founders have mastered their idiosyncrasies. Even the easily cast alloys may prove a source of much trouble when they are shaped into castings that are expected to withstand the pressures of gases or liquids. The more commonly used alloys in brass foundries are the alloys of copper with tin, having small additions of zinc and lead, known as gun metals, bell metals and hard brass; alloys of copper with tin and lead for bearing purposes; alloys known as red brass or composition; and alloys of copper with zinc mainly, known as yellow brass. Such special alloys as phosphor bronze and manganese bronze fall naturally into the foregoing classes. Phosphor bronze may be composed of copper and tin with phosphorus; or of copper, tin and lead with phosphorus. Manganese bronze is a special kind of yellow brass. Aluminum bronze is in a class by itself, not only on account of its composition but because of the difficulties encountered in shaping it into castings.

Qualities Are Unusual

The alloys classed as red brass are the easiest to cast, and yellow brass is the most difficult of the ordinary alloys to cast. The strictly copper-tin alloys may perhaps be classed midway between red and yellow brass as far as their casting properties are concerned. The difficulty experienced in casting yellow brass is caused by the greater chemical activity of zinc as compared with tin and lead, and it may be stated that as a general rule the difficulty of casting any alloy of copper will be found to increase in proportion to the chemical activity of the chief alloying element. Thus yellow metal is more difficult to cast than red brass or gun metal, and aluminum bronze is more difficult to cast into sound castings than any alloy used, with the possible exception of the high nickel alloys. In this latter case, a high melting point is one of the factors to figure with, and sometimes also the high melting point of the nickel copper mixture is combined with the chemical activity of zinc, as in the case of nickel silver.

Variation in Composition

There is a considerable variation in the composition of the alloys known as red brass, and due to this variation they do not all cast with the same ease. This is a point not unfrequently lost sight of in brass foundries, with the result that one of the more difficult alloys may be selected simply because of its slightly lower first cost. The final cost of the castings though, may be considerably higher than would have been the case had a selection been made of one of the better appearing and more easily cast alloys. The content of zinc will afford an index to the casting qualities of a red brass. One containing from 3.5 to 5.0 per cent zinc will be superior in this property to one containing from 10.0 to 14.0 per cent zinc. There are, broadly speaking, four types of red brass alloys: those in which zinc predominates over the other alloying white metals; those in which lead predominates; those in which tin predominates; and those in which the three alloying metals are equal, or nearly equal in quantity. There is no unanimity in the use of these various alloys; thus one manufacturer of bibbs or valves may use an alloy of copper, zinc, lead and tin of diminishing content in the order named, with zinc placed at 5 per cent, or a little over, and another manufacturer will use, for identically the same line of goods, an alloy with a zinc content of over 10 per cent, a lead content of over 50 per cent of the zinc content, and a low percentage of tin. Of the two manufacturers, the latter will encounter the highest loss in turning out his product, other matters being equal in the two cases. The reason for this lies in the higher zinc content of the alloy, and in addition to a higher production loss, the product made with the cheaper alloy will look yellowish and what it is—cheap. In consequence it is likely to cost more in time and money to sell than the better appearing product. Therefore, when all these matters are considered, it is not stretching the point to remark that there is every possibility that the cheaper mixture may cost more in the end. In any case the possibility is something to be carefully considered and figured over.

Aluminum bronze has been cited as an example of an alloy difficult to cast because of the great chemical activity of the alloying metal, aluminum. Now while aluminum in itself is not a difficult metal to cast, one requirement to success that is well known is control of casting temperature. The aluminum must not be heated to more than a blood red for casting into sand molds. When aluminum is alloyed with copper to form aluminum bronze, it is unavoidably heated to a temperature much above its melting point, and as the activity of aluminum increases with temperature, liquid aluminum bronze always is carrying a chip on its shoulder, looking for trouble, metaphorically speaking. All of this adds to the cost of producing castings, a cost increase that should be passed along to the consumer to permit the brass founder handling such alloys to continue in business.

Magnesium Alloys Troublesome

Magnesium also furnishes examples of the difficulty of making castings of metals having great chemical activity. Castings of this metal, or of alloys with a magnesium base are only produced by taking precautions undreamed of with other metals, and which increase the cost of the castings. Also when 5 per cent or more of magnesium is added to aluminum to make the alloy known as magnalium, the difficulty of casting the alloyed aluminum is greatly increased. Alloys of magnesium and copper cannot be cast in sand molds, even the addition of under 1 per cent of mag-

nesium to any yellow brass will render the casting of it impossible. It is also not possible, with our present knowledge, to cast an alloy of copper with 1 per cent of calcium in a sand mold and get a decent casting externally, or one that is sound internally. These examples will suffice to show that the chemical activity of the alloying element greatly influences the casting properties of an alloy, and that because of the superior activity of zinc to the other metals tin and lead, alloys of copper and zinc, known as yellow brass present problems peculiar to themselves.

Rests With Mold or Core

The responsibility for defective castings of nonferrous alloys may rest with the mold or core, the mold or core material, or with the metal itself which may be oxidized, or created while it is being melted. Oxidation produces castings that leak under pressure, or that may be defective because of surface dross, and aeration gives castings filled with holes under the skin, a condition known as porosity. In addition to the possibility of oxidation or aeration during the melting process, which is the result of ignorance or carelessness, defects may show in the castings that are directly traceable to some peculiar property of the alloy itself, such as excessive shrinkage, tenderness at some critical period of solidification, and abnormal dross production.

The first peculiarity promotes draws and cracks where angles are formed by the casting, or at the junction of a light and heavy section. It also causes what should be flat, level surfaces to come concave or shrunken. The second peculiarity, when combined with the first, is responsible for cracks in the castings and is especially difficult to circumvent. The third peculiarity, abnormal dross production, renders necessary the employment of special and often difficult molding methods to avoid all agitation of the stream of metal entering the mold, which adds greatly to the expense of producing castings. Aluminum bronze, monel metal and some aluminum alloys, possess the peculiar characteristics referred to, and are in consequence subject to losses.

Defective castings also may be produced by filling the molds with metal of incorrect temperature; it may be either too hot, or too cool. Probably many other sources of loss of castings could be enumerated, but the list has already reached formidable proportions.

In the production of castings two major operations must proceed simultaneously—the construction of molds and the melting and alloying of metal. While it is advisable for the molding to be a little ahead of the melting, the latter should never be ahead of the molding, otherwise the metal has to be held liquid in the furnace, and this cannot be done without some deterioration due to oxidation, sulphurization and aeration, or gasification, even when the molten surface is kept carefully covered with charcoal. In passing it may be remarked that when molten copper or its alloys unavoidably must be held liquid this can be accomplished, with the least changes within the metal, under a covering of a molten flux, or of flux mixed with charcoal. The flux presents an unbroken covering over the metal bath and excludes the furnace gases.

As a selection of the proper grade of sand is so important to the molding, so is a selection of the most suitable metal to the melting and alloying operation. Whenever castings high in physical properties or that are required to withstand pressures, are to be made, the metal must be clean and dense, free of oxides and gas holes. In this connection it is important to select raw metals free of such defects. The difference between oxidation and aeration lies in the fact that the first named produces a nonmetallic substance or dross that becomes a part of the alloy, while the second is a condition resulting from the commingling of a gaseous body with the alloy, and which is retained after solidification.

Oxidizing Flames Harmful

Dealing first with oxidation; molten metal is not exposed to the atmospheric gases which consist of four-fifths nitrogen and one-fifth oxygen, but to the gases of the furnace atmosphere, which differ with different furnaces. In oil-fired noncrucible combustion furnaces the atmosphere generally will be oxidizing, that is, will contain free oxygen. This means that all the other gases present would be combined with all the oxygen they could take up; thus carbon monoxide would be oxidized to carbon dioxide, the sulphur present would become sulphur dioxide; and hydrogen would become oxide of hydrogen or water—steam at that temperature. In coke-fired crucible furnaces there probably would be more sulphur dioxide at all times; more oxygen when the coke had burned to incandescence, and more carbon monoxide when fresh coke is added. Such an atmosphere would be more harmful to heated copper than that of the oil-fired open-flame furnace, therefore there is greater need for a covering to protect the crucible melted metal than in the noncrucible furnace.

Copper, when heated, has a strong affinity for oxygen. It is not necessary to melt the copper to have it oxidize. Thus an ingot of copper heated red hot and allowed to cool turns black due to a coating of oxide, but if plunged into water it will turn red because of the scaling off of the black oxide. The red color under the black coating is not the natural color of the copper, but the color of a second oxide of copper which adheres strongly to the copper. This oxide is formed first, then changes to the black oxide. When copper ingots are melted in contact with an oxidizing atmosphere, they oxidize on the surface, then this layer melts off exposing a fresh surface to oxidation and this process of oxidation and exposure continues until all the copper is melted, or the molten bath formed submerges the balance of the ingots. Using an oxidizing flame to melt bare copper, it is evident, will produce a large amount of oxide which will melt and dissolve in the metal which then becomes a mixture of dross and metal instead of a pure, clean metal. Such an admixture will not be fluid like the clean metal. It will be thick, a very undesirable condition. It is easy to produce such thick copper and difficult to do anything with it in a brass foundry when it is once formed. Prevention, then, is much better than cure. This takes the form of crucible melting furnaces of adding charcoal to the contents of the crucible. The charcoal affords protection by burning, that is by taking up oxygen itself. This depletes the available supply of oxygen within the crucible, so there is less to oxidize copper. But this is not all, within a crucible the charcoal cannot get all the oxygen it requires to burn completely, so it only partially burns, producing carbon monoxide, a gas which has a strong affinity for more oxygen. Accordingly this envelope of carbon monoxide surrounds the heated copper and prevents oxygen from getting to it to form oxide, but should any oxide have formed on the copper before the gas was evolved, it is reduced by the gas. Thus the oxygen is abstracted from the copper, leaving it again in the metallic condition.

Protects the Metal

To get full advantage of this action of carbon monoxide produced by the burning of charcoal in a crucible in protecting ingot or other shapes of copper from oxidation, it is neces-

sary to take a few precautions. Thus should the copper be stacked in the crucible in such a manner that one side leans over the crucible edge, that portion of the ingot will fail to be enveloped by the stream of carbon monoxide gas as the latter being evolved from within the crucible will ascend straight upwards, and what is left of it will pass away with the products of combustion. The outside of the ingots will then oxidize as before described, and although due to the employment of charcoal, much less oxide will be formed, there will be sufficient of it to do serious harm, especially for making pressure-tight castings, as is shown later.

Safeguard Against Oxidation

This oxidation of copper can be guarded against by adding no more copper than can be held within the walls of the crucible, or by stacking the ingot centrally within the crucible putting the charcoal in the space between the crucible walls and the copper. Another and better way is to use a deepener on top of the crucible. This deepener costs nothing as it can be made by chopping off the bottom from an old crucible and using the ring left. This ring, or deepener, is simply set on top of the crucible after the latter has been coked. On no account must coke be placed around the deepener, for if it should be, the deepener will be firmly wedged in place by some of the coke around it, then as the weight of the crucible and contents makes it sink through the burning fuel, a gap will open between crucible and deepener. In this case the coke stacked above the top of the pot will roll down into it and fill it. In melting with crucibles this is one of the most annoying things that can happen outside the breaking or leaking of the crucible. The ring simply must be set on top of the crucible, when it will sink down with it. The use of such a ring permits all the charge of copper to be placed within the crucible at once, when it is cold, shielding the copper from the furnace gases and assisting in enveloping the metal in the gases from the charcoal. The deepener should be considered indispensible for crucible melting; it saves fuel and time and produces cleaner metal. Some melters dispense with the use of such aids as deepeners, and in melting a heat containing ingot copper, place several ingots of the latter on top of the crucible or on the coke alongside the crucible in order to heat up and save time. This should never be permitted as copper placed outside the crucible has not protection whatever. It may not be melted but it will be oxidized, and while such oxidation may be unimportant in making some classes of brass castings, nothing is gained by practicing it.

Before taking up means of preventing oxidation of copper, or other alloyed metal, while it is being melted in oil-fired noncrucible furnaces, it will be well to consider just what is meant by a deoxidizer. The word is applied to substances that possess the power to take the oxygen from other substances that may have combined with this gas. They are deoxidizers as far as their relation to the substance they may have robbed of oxygen is concerned. In their relation to still other substances they may be the reverse of deoxidizers for they may then take the role of the deoxidized. Thus in their relation to copper, zinc, lead and tin are all deoxidizers; that is, they have the power to take the oxygen from the oxides of copper, becoming oxides themselves and leaving metallic copper. The metals may be likened to wrestlers, one being stronger than the other. Thus of the three metals tin, lead and zinc, lead is the weakest, but it is stronger than copper in its ability to take oxygen away from other metals. Tin is stronger than lead and zinc is stronger than either. All three metals are deoxidizers of copper, when added to thick or oxidized copper; burnt copper as some prefer to call it. These metals take away the oxygen from the copper and combine with it themselves. The action of zinc in particular in combining with the oxygen within the copper is so energetic that there is a great hissing and even splashing of the molten metal when the first addition is made. After that the balance goes in more quietly because there is no more oxygen left with which to combine.

Aluminum Mixtures Violent

Tin and lead mix with the oxidized copper quietly as they are not volatile like zinc. Aluminum also not being volatile at such temperatures enters the oxidized copper quietly, but the melt will be raised to incandescence by the amount of heat generated as the aluminum combines with the oxygen formerly held by the copper. Aluminum is so powerful in taking oxygen from other substances that the metal liberated from the oxygen by the aluminum is melted and heated to a higher temperature than is possible by melting the metal in any fuel-fired furnace. When aluminum in a finely granular form is mixed with copper oxide and the mixture is strongly heated at one point the mass will explode and throw intensely heated molten copper about in a dangerous fashion, unless the proportion of aluminum to copper oxide has been made to give a preponderance of oxide over what is shown by the equation

$$2Al + 3CuO = 3Cu + Al_2O_3$$

which is about 19 per cent of aluminum to 81 per cent of copper. However, when 12 per cent of aluminum and 88 per cent copper oxide are used the result of the reaction is copper, and this reaction has been used to produce highly heated copper to feed the risers of heavy copper castings.

Use Special Feeder Heads

It often happens when such castings are made the heads draw down, that is, a shrink cavity forms that is likely to reach down into the casting itself thus leaving a hole after the riser has been cut off. If a dry sand riser head, funnel shaped, is placed over the riser and filled with the mixture of copper oxide and aluminum in the proportions given and is then fired by igniting on top of it a mixture of barium dioxide and magnesium sawdust, hot molten copper will be formed instantaneously and will shoot down into the cavity in the riser, filling it solidly with metal. Aluminum is thus a mighty deoxidizer, and we have cited it here to show that the most powerful deoxidizers are not necessarily the best, for it is too well known that aluminum cannot be employed as a deoxidizer in the case of the usual brass foundry alloys for it to be necessary to discuss the matter here.

When copper is oxidized it cannot be restored by adding some element with power to deoxidize it, when the oxidation has been permitted to go on until the copper loses some degree of its natural fluidity. However, the addition of a suitable deoxidizer will greatly improve copper, or the alloys made from the copper, provided the latter, when in the condition known as tough pitch, has been melted with a view of controlling oxidation. This is because the small amount of oxide then contained within the copper is exchanged for another oxide which is less harmful than copper oxide to the properties of the alloy, or that when in small amount eliminates itself by rising to the surface of the alloy. The act of deoxidizing is merely an exchange of oxides, thus when lead is added to oxidized molten copper, copper oxide is reduced and lead oxide formed, and if tin is added instead of lead, tin oxide is formed and substituted for the copper oxide. The same holds

good for zinc, or any other metal that has the power to deoxidize copper. Copper oxide is merely exchanged for another oxide, and whether the metal will be improved by the substitution will depend upon how quickly the new oxide formed rises to the surface of the molten mixture. Copper oxide does not rise to the surface because it is soluble in liquid copper, and only separates as the copper solidifies. Then it is too late for it to rise out of the metal. By deoxidizing the copper another oxide may be substituted for the copper oxide, which is not soluble in molten copper.

Molten metal being of a viscid nature it is evident that any oxide that takes the form of a finely divided powder will be slow in rising through the metal and some of it will be entangled and will remain. An oxide that has a low melting point and melts to a fluid slag at the melting temperature of copper, and which, in addition, is not soluble in copper, would rise more quickly and easily to the surface. Also, if to the fluidity of its oxide was added a thinning action in the alloy, thus rendering it more fluid, the action of this deoxidizer would be all the better, provided there were no counteracting defects. Phosphorus is such a deoxidizer and because of these properties it is one of the most valuable we possess.

While zinc is chemically an active element, it is not an ideal deoxidizer because its oxide is of a powdery nature and also is difficult to fuse. Being light and powdery it fails to rise through the bath of metal quickly, that is before solidification, unless the melting period is much prolonged. Therefore, if it is added to badly oxidized copper, the zinc oxide formed remains in the alloy, the fluidity of which is not improved, but is lessened by the admixture of this infusible oxide, the result being the production of a mass of metal known as a salamander because it cannot be melted unless broken up and treated with some flux that liquifies the oxides and brings them to the surface of the bath of metal. Such salamanders form around the sides of crucibles as they are used and grow constantly thicker. It is nothing for melters who do not believe in the use of proper fluxes to have partially worn out crucibles around that are half filled with salamanders caked around their sides. Such salamanders never form when fluxes are used consistently, and judiciously.

How and Why in Brass Founding

By Charles Vickers

Eliminating Cracking in Bearing Metals

In lining car journal bearings we have been troubled with the lining cracking and we would like your suggestions as to a better alloy than the one we are using, or how to avoid the trouble. The alloy we use is tin, not more than 5 nor less than 3 per cent; antimony, not more than 10 nor less than 8 per cent; lead, not more than 88 nor less than 85 per cent. The bearings are required to withstand 70,000 pounds pressure. We desire to eliminate the tin as much as possible.

Antimonial lead, consisting of lead, 80 per cent; antimony, 20 per cent, is used largely for lining car journal bearings, and appears to have given satisfaction for many years. We would not consider a limit of 100 per cent antimony wise as such metal would be too soft, also it has been found that the less antimony there is in the alloy the greater is the tendency to crack. The antimony should be increased to 15 per cent, or antimonial lead may be used if any change in composition is permitted.

The temperature of the metal in the kettle should be such that it will char a stick of wood but not cause it to burst into flames. The tin in the alloy causes it to run more fluid but does not harden it; hardness is secured through the antimony. The pouring temperature of an alloy containing 10 per cent antimony, 5 per cent tin, balance lead, is 616 degrees Fahr.; that of an alloy with 15 per cent antimony, 5 per cent tin, balance lead, is 625 degrees Fahr. If the antimony is increased and the alloy is not overheated and is poured at the proper temperature, cracking will cease.

Babbitt Will Not Adhere

We are manufacturing car journal bearing brasses and experience difficulty in getting the babbitt to adhere properly to the face of the brass. We grind the brasses out thoroughly before tinning them and apply the solder with the aid of salammoniac and muriatic acid. Can you advise us what to do.

The proper way to finish a car journal bearing prior to running in the lining is to machine the surface on a special boing mill provided for the purpose. It always is difficult to get the solder to adhere to a bearing ground out because the grinding wheel does not cut away the oxidized surface in the same manner as a machine tool. It has a tendency to burr it over and bury it and as a result the solder will not adhere to the surface. Irespective of subsequent teatment, difficulty always will be experienced in trying to make solder adhere to a surface that is not perfectly clean. You might try swabbing the bearing with a flux of chloride of zinc after the muriatic acid has been applied. The chloride of zinc is made by dissolving metallic zinc in muriatic acid.

Pickling Brass Castings

We wish to learn whether pickling brass or bronze castings reduces the strength, as we have been given to understand this is the case.

As the pickling or dipping merely removes the film of oxide from the surface of the brass castings, and as this film possesses no strength we are unable to discover in what manner the pickling could reduce the strength of the metal. A properly cast test bar of red brass, gun metals or manganese bronze is a round rod of the requisite length, ¾ inch in diameter, and this rod is turned off at the central portion to the standard dimensions of a test bar, thereby removing the skin and a portion of the metal at this point. This does not decrease the strength of the test bar, provided, as before mentioned, it had been molded properly, with a view to feeding the shrinkage perfectly. This has been determined as a result of much experimental work. Therefore, it cannot be believed the mere removal of a thin film by acids will decrease the strength been worked and polished are decreased of the metal.

The strength of steel objects, that have been worked and polished are decreased by pickling in acids as this effects the removal of the extremely strong film of amorphous cement that has been worked to the surface by polishing.

Cleaning Steel Castings--V

Light and Medium Heavy Castings Are Cleaned Efficiently by Sand Blasting—Handling Constitutes Important Consideration —Tumbling Adapted to Wide Use

BY HERBERT R. SIMONDS

SAND-BLAST equipment plays a role of increasing importance in the procedure required to make steel castings clean and acceptable to the user. In the present article, the concluding of a series on the subject, Mr. Simonds points to the work which is performed most effectively by the sand blast. He describes the simplest form of this equipment, which requires only a closed room, a car to hold the castings together with air and sand supplied through a hose, under pressure. Ventilation and light are two important considerations in sand-blast work. The latter is receiving more attention, as its economy is appreciated. Mr. Simonds gives some figures on time required for sand blasting a typical large steel casting and offers costs on an hourly and piece-time basis, together with an estimate of the volume of sand and abrasive required. Tumbling barrels, which in themselves form a valued adjunct to any cleaning room at present are available combined with integral sand-blast equipment.—*The Editors.*

USUALLY the first step after pulling steel castings from the mold is to transport them to the sand-blast room where the baked sand and encrusted material is removed. However, sand blasting in many cases is merely a preparation for the other cleaning operations, which are to follow. As was pointed out in a previous article in this series, the amount of cleaning which can be done by sand blasting in heavy complicated steel work is relatively low compared with that which is taken care of by chipping and the cutting torch. Of course, small steel castings are of such a nature that they can be put through the sand blast or tumbling mill and then are ready for delivery to the customer. In such cases, the sand blast becomes the major cleaning agent. Steel castings sometimes are cleaned by pickling, but this process seldom is used and will not be considered in this series.

Sprue cutters, metal saws, drop hammers, and other special tools occasionally are used to help in the difficult job of cleaning steel castings. However, these tools cannot be said to form part of the typical cleaning operation. The sand blast, on the other hand, is typical. It is safe to say that most steel foundries have as part of their cleaning equipment some sort of sand-blast equipment.

Simplicity Is Possible

Some consist in merely a room containing a table on which to place the work and a hose by which the operator may direct a blast of sand and thus clean the casting. Such a room in its simplest form is shown in Fig. 2. Here castings are placed on a small carriage which is pushed into the sand-blast room. The floor is solid and sand is recovered by shovelling it through a screen into the sand reservoir which may be seen at the left. Exhaust pipes in the upper part of the room help to remove the dust.

In larger foundries the importance of reclaiming sand with a minimum amount of labor enters into the design of the sand-blast room. Also as the weight of castings handled per day increases, the material handling equipment becomes more important. Fig. 5 shows a modern sand-blast room. Here a specially built, steel-frame car is used. The top of the car consists of a circular steel table on which castings are placed. This table is locked or released by a foot lever at the right. When the table is released, it is free to revolve and thus saves the

FIG. 1—THIS EXCEPTIONALLY LARGE STEEL CASTING DEMANDS THE USE OF CUTTING TORCH, CHIPPING HAMMER AND HEAVY GRINDING WHEEL

operator from having to walk from one side to the other. The floor of the room is almost entirely of open grid construction permitting the sand to fall through into a bin below. The ventilation air is drawn downward.

Sand-blast equipment when not used with tumbling barrels may be divided into four features.

Handling castings.
Air and sand supply
Ventilation
Sand recovery.

Under handling provision for holding the casting at the proper level during cleaning may be considered. Many foundries find some sort of a small push car to be satisfactory for this purpose as this combines a support for the casting with means for transporting it into and out of the sand-blast room.

Recently the overhead trolley has met with considerable favor for transporting castings to and from the sand-blast room. Such a trolley extends through the center of the room and thus permits heavy castings to be carried directly into the room. Without such an overhead trolley, it is necessary to carry the castings from the molding floor either by crane or some other means to the car which is run outside of the sand-blast room to receive them. The car then must be moved by some means into the room. This is often done with the crane. A cable fastened to the inner end of the car runs over a pulley and then back out of the door of the room where it is picked up by the crane hook. Movement of the crane away from the sand-blast room pulls the car into place. The car is pulled out by attaching a cable from the crane to a lug on the front of the car. One foundry with an extensive overhead trolley system has constructed its sand-blast equipment over one section of the trolley. The castings to be cleaned then are passed into the sand-blast room from one side, hang on the trolley while being cleaned, and afterward pass out at the other side of the room. Thus the cleaning room becomes a link in the path of the casting which, therefore, continues in one direction.

FIG. 2—SAND BLASTING REQUIRES ONLY THE SIMPLE EQUIPMENT SHOWN HERE IN ITS ELEMENTAL FORM

Operating the Sand Blast

A comparison of the casting in Fig. 4 with the one at the left in Fig. 6 will illustrate the type of work handled by the sand-blast. These two views show a similar casting before and after sand blasting. This particular piece weighs 1400 pounds and some further details in connection with its cleaning will be taken up later under the heading of costs.

The operation of the sand-blast is not as simple as it at first appears. An inexperienced operator will use nearly twice as much sand for a given casting as will one who is thoroughly familiar with the work. On complicated work such as that shown in Fig. 4, bent nozzles are necessary. A bent nozzle always wears out more quickly than one which is straight, so that where possible straight nozzles should be used.

Conditions vary so in sand-blast equipment in respect to pressure and size of holes, that it is difficult to recommend any particular practice. However, some details in connection with the successful operation of a modern sand-blast plant may serve as an indication of what may be expected under given conditions. Complicated steel castings ranging from 100 pounds to 4000 or 5000 pounds are sand blasted by one manufacturer in a series of steel-walled rooms, each room being supplied with tracks and a small car. The castings are brought to the front of the sand-blast department by crane and are placed on the cars as required. In most cases the rooms are small, 12x15 feet, and contain one hose connection in the center of the back wall. Where the casting is on a stationary top car as shown in Fig. 4, the operator, of course, moves around the casting as he cleans it.

One of the most important considerations in his work is proper lighting. Strange as it may seem, this feature often is overlooked even where manufacturers have gone to heavy expense to put in modern appliances in every other respect. Because of the quanitity of dust and small particles in the air, it is necessary for the operator to wear some sort of a hood or helmet, and this cuts down his vision. Also, the dust

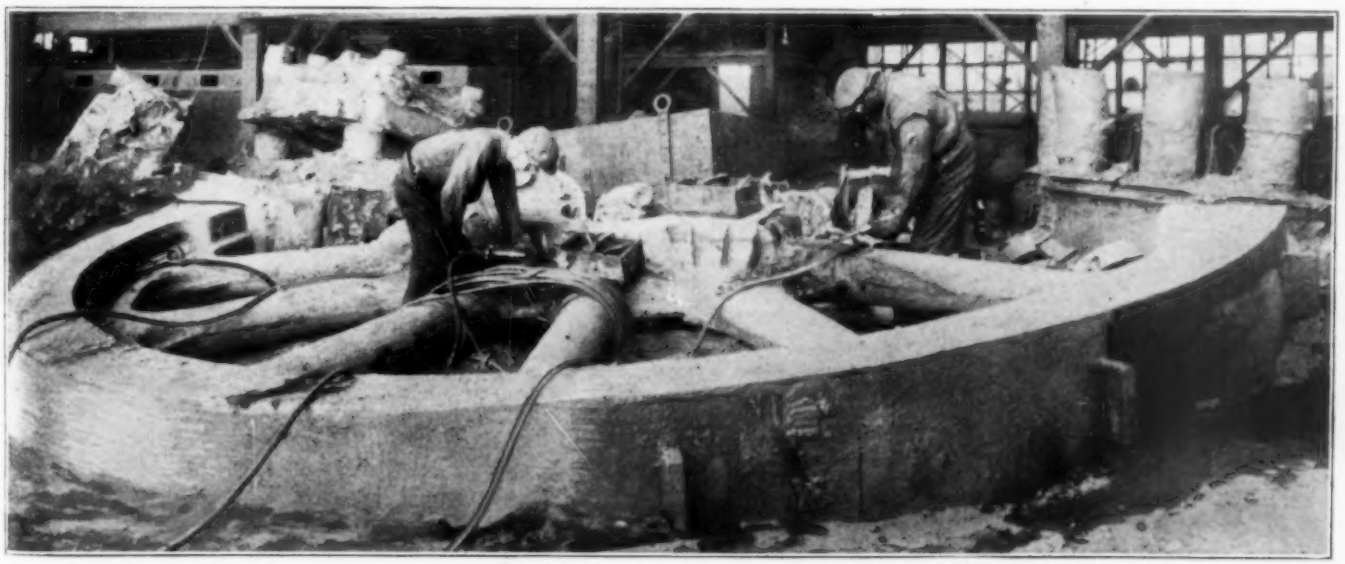
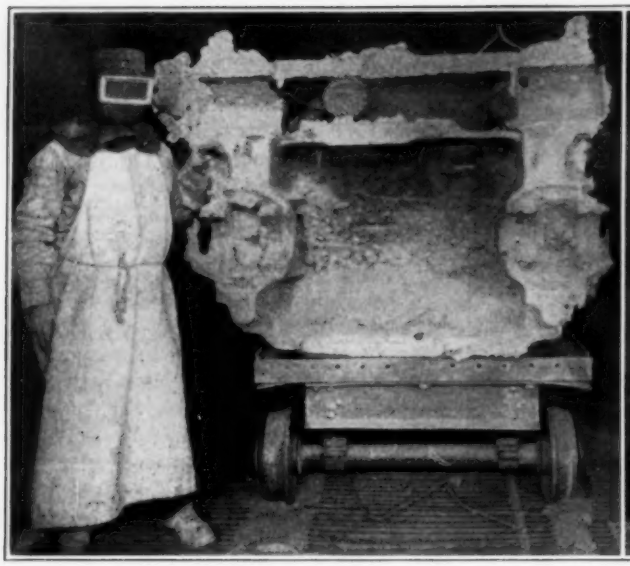


FIG. 3—FINAL STAGES OF CLEANING THE CASTING SHOWN IN FIG. 1—NOTE THE GREAT AMOUNT OF MATERIAL WHICH HAS BEEN REMOVED



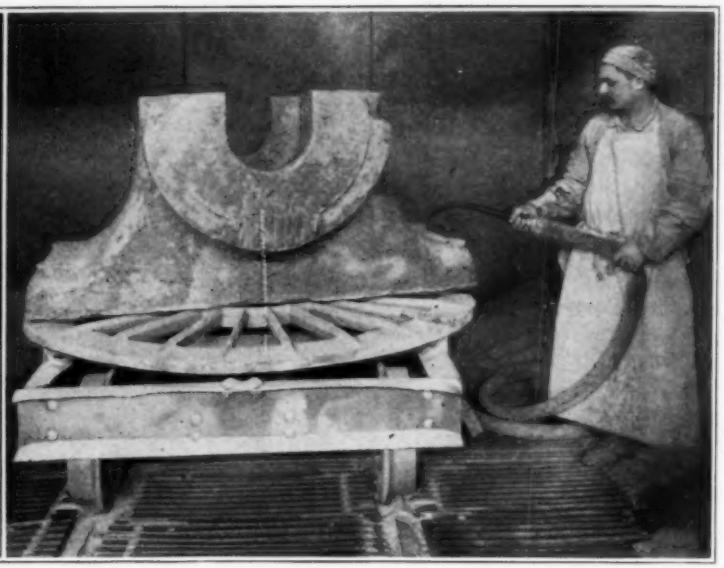


FIG. 4—ONE FOUNDRY CLEANS CASTINGS LIKE THESE ON A PIECE-TIME BASIS. FIG 5—MODERN TYPE UNIT WITH REVOLVING TABLE CAR, GRID FLOOR TIGHT, VENTILATED ROOM AND AMPLE LIGHT

itself interferes with his seeing the casting clearly. If in addition to all this, the lighting is poor, the operator is forced to work more or less blindly. He holds the nozzle towards the casting, and when he thinks he has held it long enough he moves to another point and so on until he has made the complete circuit. Then he usually opens the doors, takes off his helmet, and examines the casting under the better light which he gets through the open doors. If he finds he has missed a few places, he makes note of these, closes the doors and starts in again.

Wasted Effort

This is one cause of wasted time due to poor light. Another, and probably a more common cause, is over blasting clean surfaces. If an operator cannot see when a surface is clean, he usually continues the work longer than the actual cleaning requires. The walls of sand-blast rooms, which are almost always black, absorb most of the faint light which commonly is supplied. The sand-blast operator works under enough disadvantages at the best, and it is only the simplest form of economy that he be given adequate light.

Because of the difficulties which attend working in a sand-blast room, various automatic and semiautomatic and blasting methods have been developed. One of the commonest forms of an automatic, sand-blast machine consists of a large revolving table half of which is inclosed and half exposed. The castings are loaded on the exposed part and then revolved through 180 degrees, where they are inclosed and subjected to sand blasting which is designed to reach all parts of the casting.

The usual type of semiautomatic, sand-blast equipment consists of a revolving table on which work is placed. The operator standing outside of an inclosure extends his arms through tight fitting openings and holds the hose and nozzle which are within the opening. A small piece of glass before his eyes enables him to see what he is doing. Equipment of this sort has proved to be successful for castings from 50 pounds to 300 pounds and where the surfaces are such that they may be cleaned with a straight nozzle playing against the outside of the casting.

Usually when it is necessary to work the nozzle from within the casting and against interior casting walls, this method has failed to operate to the best advantage. The sand-blast equipment shown in Fig. 5 has proved satisfactory on a wide variety of work. The air pressure used here is 35 pounds and the hose is 1¾ inches outside diameter. In a normal operation the hose lasts, with but few repairs, for three months. The nozzles as shown are replaced three or four times a day. The fitting at the end of the hose which holds the nozzles lasts from three weeks to a month.

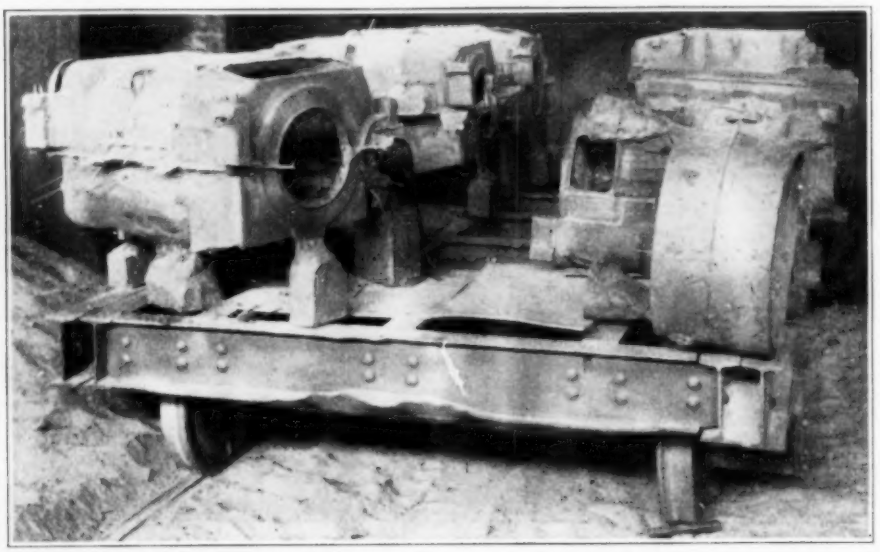


FIG. 6—LARGE SAND-BLAST ROOMS ARE REQUIRED TO ACCOMMODATE CASTINGS SUCH AS THESE WEIGHING 1200 TO 1500 POUNDS EACH

Reclaiming Sand

On steady work this installation uses about 2500 pounds of sand in a nine hour day. About 6 inches below the floor, is a quarter inch mesh screen which retains all large particles of foreign material, and allows the sand to fall through. The sand is carried by elevator up to separators where the dust and all particles below a certain size are removed. The remainder, together with such new sand as may be needed, drops down a chute over individual hoppers connected with air reservoirs. Fig. 7 is a back view of a typical sand-blast installation. The upper floor in

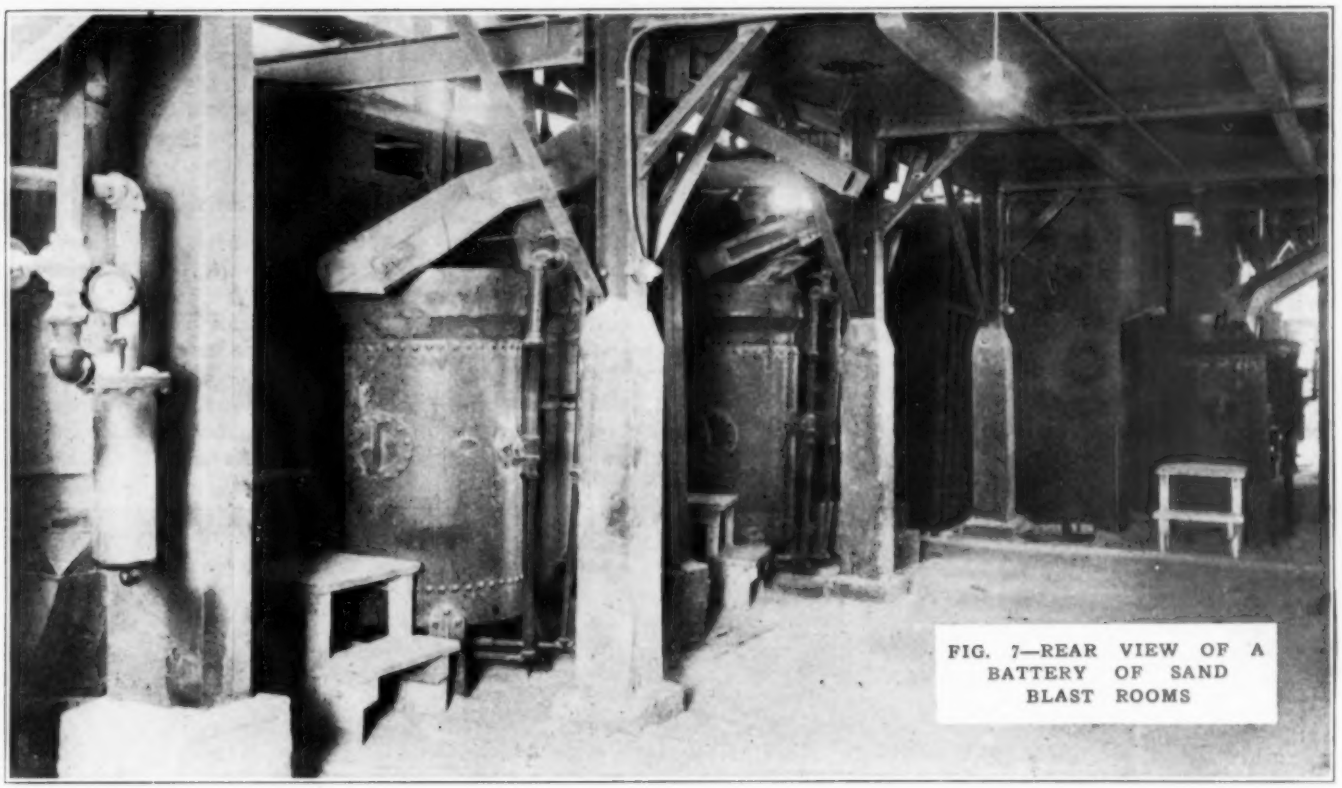


FIG. 7—REAR VIEW OF A BATTERY OF SAND BLAST ROOMS

the photograph carries the dust separators and new sand storage. The inclined chutes which pass over each air reservoir are those which return the sand to the hoppers. Valves in the bottom of each hopper permit sand to drop through into the reservoirs as needed. In normal operation they are closed. These valves should be inspected frequently and kept in good repair, for here is one cause of leaks and the consequent loss in pressure at the nozzle.

It is important to have a good coarse sand or artificial abrasive. Most foundries have found it poor economy to attempt to use over again sand which has broken up into small particles. By varying the air pressure in a dust separator, the size of particles retained may be regulated within narrow limits.

Ventilation of a sand-blast room is an important consideration. The room shown in Fig. 5 has air openings at the top for fresh air to enter and at the back about 10 inches above the floor line there is a long narrow exhaust opening. This is attached to a large power exhauster, but intermediate between the exhauster and the sand-blast room there is a separator which reclaims such sand as may have passed through the wall opening instead of falling through the floor.

Caring for Equipment

Like nearly all apparatus, proper care and inspection of sand-blast equipment pays for itself many times over. A mixture of air and sand is traveling at a high rate through the hose and nozzle all the time the blast is in operation, and this, of course, has a strong abrasive action. Sharp turns and kinks in the hose should be eliminated whereever possible and shoulders within the pipe should be tapered off so as to present the least possible resistance to the rushing sand particles. When a hose wears out in one place and still is fairly good through the remainder of its length it may be repaired by cutting out the poor section and inserting a short length of steel pipe with hose clamps at each end. This, of course, leaves a small shoulder at the upstream end of the pipe. It is good practice to smooth this

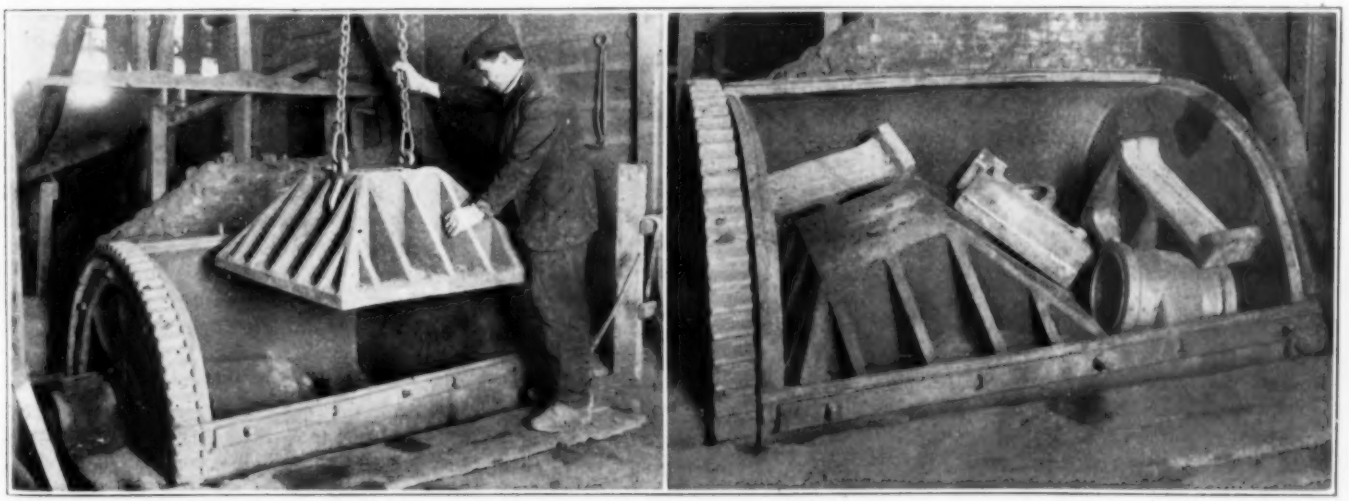


FIG. 8—MOUNTING THE TUMBLING MILL BELOW THE LEVEL OF THE FLOOR FACILITATES LOADING. FIG. 9—SOME EXTREMELY HEAVY CASTINGS MAY BE TUMBLED PROFITABILY

shoulder with a coarse file before inserting the pipe. The same is true of shoulders at the end of the hose caused by the nozzle holder. Shoulders not only cause excessive wear due to eddies set up in the sand stream, but they cause a reduction in effective volume.

Costs Not Uniform

The air compressor equipment described in the previous article of this series may be used for sand-blast rooms. One sand-blast nozzle of the dimensions mentioned will consume about 150 cubic feet of air per minute. The air supplied for chipping hammers usually is supplied at a pressure of from 90 to 100 pounds, and therefore it is necessary to have reducing valves before air at this pressure can be used at the 35 pounds pressure desired for sand-blast work.

An attempt at arriving at sand blasting costs immediately encounters the wide range between the cost of cleaning a simple casting and that of cleaning a complicated casting. The casting shown in Fig. 4 and at the left of Fig. 6 weighs 1400 pounds after it is taken from the mold. Ordinarily on straight time, this casting requires about 45 minutes for cleaning by sand blasting. However, it has been included successfully in a piece-time schedule at 26 cents per piece. When figured per hundred pounds of good castings, the direct labor charge for sand-blast cleaning at one foundry ran between 4 cents and 5 cents. In addition to the direct labor charge, the amount of sand averaged from 250 pounds to 300 pounds per hour or 20 pounds per hundred pounds of good castings. The cost of air ran about 900 cubic feet per hundred pounds of good castings and the cost of nozzles and hose figured about 1½ cents per hundred pounds of good castings. The total sand-blast cost averages about 15 per cent of the total cleaning cost in steel castings work, and at one foundry runs close to 10 cents per hundred pounds.

Small, uncomplicated castings often are cleaned of baked sand by tumbling barrels. In some foundries tumbling barrels are used for castings up to a ton or more in weight. Fig. 8 shows a casting weighing 2200 pounds being loaded into a large tumbling barrel. Here for convenience in loading, the barrel is mounted at the floor level instead of above it as in the usual case.

Castings Held Stationary

Fig. 10 shows one end of the cleaning department in a large modern foundry. Castings are loaded in these barrels by crane and after being carefully packed, a quantity of shot such as shown in the shovel in the illustration is placed upon them. The door of the barrel then is closed and the whole is rotated. In this type of barrel, the castings are packed so that there is little rolling of the castings back and forth as the barrel revolves. The cleaning action comes entirely from the shot which percolates throughout the entire mass and keeps rubbing and bumping back and forth until the casting has acquired a polished surface.

Large Castings Cleaned

A tumbling barrel takes considerable more time than the sand-blast to clean the same casting, but this extra time is more than made up by the reduced labor cost in the case of the tumbling barrel. A popular piece of cleaning apparatus in iron foundries is the combination of tumbling barrel and sand-blast. Tumbling barrels should be supplied with an air system which carries away the dust and small particles, and usually a strong flow of air pays for itself in much quicker cleaning. The air is admitted at or through the shaft at one end and exhausted in the same manner at the othed end. In Fig. 10 the supply and exhaust pipes are shown. The ends of the barrels are perforated steel plates, the air passing through the perforations. The tumbling barrels in Fig. 10 when fully charged hold 8 tons of castings, and from 200 pounds to 300 pounds of stars are mixed in with this load. A usual type of casting cleaned in the barrel shown is a gear weighing 172 pounds. About 92 of these pieces are packed into the tumbling barrel and cleaning is considered complete in from a half hour to two hours. The method

FIG. 10—STRONG AIR SUCTION REMOVES DUST FROM THE TUMBLING BARREL

of packing pieces of varying sizes in a tumbling barrel is shown in Fig. 9. Small simple castings undoubtedly are most economically cleaned in some form of tumbling barrel or some form of barrel and sand blast.

The difficulty in cleaning steel castings is readily apparent from a glance at Fig. 4. This illustrates the different kinds of cleaning necessary, and incidently shows work which falls into the general divisions covered by the series which is concluded with this article. Oxyacetylene torches are used for the headers and heavy gates; chipping hammers for the fins, wires, and small gates; snagging wheels to smooth up surfaces left by the chipping hammers, and last in point of treatment in this series, but first or second in actual sequence, the use of the sand blast to remove the baked sand and light fins which are clearly shown in the illustration, accompanying the several articles.

Testing Permeability of Molding Sand

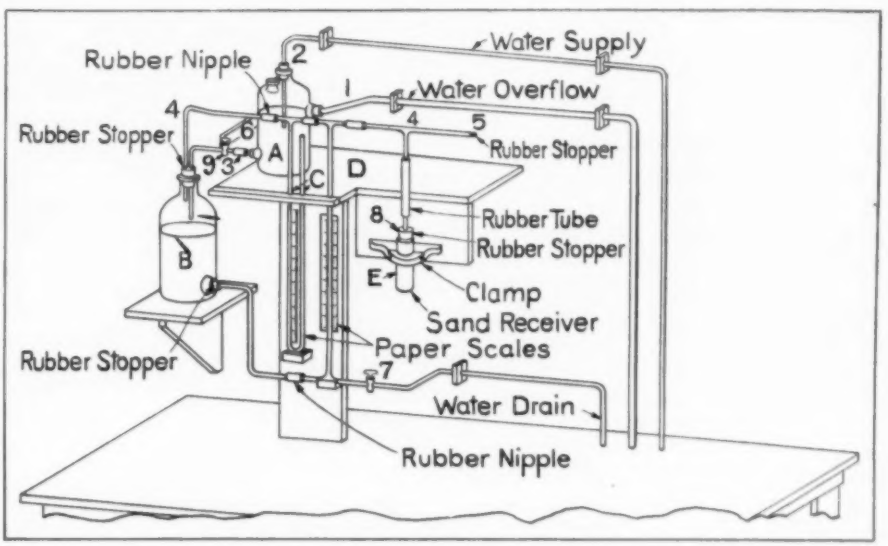
THE following method for testing the permeability of sand was presented at the Cleveland convention of the American Foundrymen's association by the joint committee on molding sand research.

Permeability, as used in this test, is that physical property of sand which permits the passage of gases. It is upon this property of permeability that the venting qualities of sand molds and cores depend. A sand of high permeability has good venting quality because of its openness. The natural characteristics of the sand and its binders, the density with which these are packed, and the percentage of moisture used for tempering, are important factors in regulating the degree of permeability. The object of the permeability test is to determine the rate of the flow of air per unit pressure through a standard specimen of sand.

The apparatus, shown in the accompanying drawing, consists of the arrangement of parts whose functions are indicated in the following description. A 4-liter water reservoir bottle, *A*, is provided, with three glass tube connections. An overflow, 1, through a ¾-inch (1.9 cm) tube, maintains the constant height of water level. A supply water tube, 2, diameter ½ inch (1.27 cm), extends below the water level, and supplies water to the reservoir when the apparatus is in operation. A water outlet tube, 3, diameter 0.236 inch (6 mm), having a 0.236-inch stopcock, 9, with a 0.157-inch (4 mm) hole, delivers water from the reservoir bottle, *A*, to the air displacement bottle, *B*. The height of constant water level in reservoir bottle, *A*, is 18 inches (45.72 cm) above the discharge side of the 0.157-inch hole of stopcock, 9, and the end of the tube is 4½ inches below the stopcock.

An 8-liter air displacement bottle, *B*, is provided. This has connected to it through a rubber stopper, a water outlet tube, 3, as described in the preceding paragraph, and an air outlet tube, 4, diameter ½ inch (1.27 cm), which leads to a manometer, *C*, a water level gage, *D*, and a sand container *E*.

The manometer, *C*, has placed behind it a paper scale. A line drawn across this scale, at approximately the center, is zero. Centimeters divided into tenths are laid off in both directions from this center line. One cubic centimeter of water weighs 1 gram. Therefore, each reading of 1 centimeter on this scale indicates a pressure of 1 gram per square centimeter. The manometer, *C*, contains sufficient water to bring the level in both legs to the zero line. The end of air outlet tube, 4, is closed and opened by means of a rubber stopper, 5, or stopcock, if it is desired to substitute this for a stopper.



ASSEMBLED APPARATUS FOR TESTING MOLDING SANDS

A water level gage, *D*, is provided with a paper scale placed behind it, graduated to show cubic centimeters of air displaced in bottle, *B*, which should be calibrated in units of 1000 cubic centimeters (1 liter). The air displaced in bottle, *B*, is read in liters by noting the rise of the water column in gage, *D*.

The sand container, *E*, is a brass cylinder 6 inches (15.24 cm) high, and 2 inches (5.08 cm) inside diameter.

The rammer consists of a steel rod having a diameter of ¾ inch (1.90 cm), supported by two steel guides. A steel disk 1-inch (2.54 cm) thick, and 1 31/32 inches (5 cm) in daimeter, is attached to the lower end of the rod. This disk has a sliding fit in the sand container, *E*. A cast-iron rammer head weighing 14 pounds (6350.36 grams), slides on the rod, its movement being regulated by two stops. The distance between these stops is sufficient to permit a 2-inch (5.08 cm) movement of the rammer head. The total weight of the assembled rammer, including disk, rod, stops, and head is exactly 17.5 pounds (7938 grams). A pedestal is provided on which the sand container, *E*, rests while the sand is being placed in this container, and while the ramming operation is being performed. The construction of the ramming apparatus is indicated in the illustration.

The water flows from the reservoir bottle, *A*, into the displacement bottle, *B*, thereby forcing the air from bottle, *B*, through the system, and on through the sand specimen in container, *E*. The resistance of the sand sets up a pressure in the system. This pressure is indicated by the manometer, *C*. The volume of air forced through the sand specimen is shown by the change in the water level on gage, *D*.

In testing sand for permeability it is absolutely necessary that the sand be properly sampled and uniformly tempered. For plant check tests upon facing and heap sands in daily use, it is proper to test the sand as tempered for the molders. For plant control tests, pro-

ceed as prescribed for the new sands.

In the examination of new sands, proceed as outlined in the four following paragraphs. Experiments should be made with different water contents from 2 to 10 per cent, or more, in order to ascertain that content which develops the maximum degree of permeability.

Dry 1000 grams of sand, selected according to the directions for sampling molding sand, for 1 hour at 105 degrees Cent., with a tolerance of 5 degrees. Care should be exercised to spread the sand over a large area in a thin layer in order to expel all moisture within the given time. This will make it possible to add the proper amount of water to give the sand the desired moisture content.

After the sand has cooled, measure out the desired quantity of water, adding sufficient extra water (usually from ¼ to 1 per cent) to allow for evaporation during mixing.* Thus, if it is desired to add 4 per cent water and ½ per cent extra water is needed, one would add 47 cubic centimeters of water (since 1 centimeter water weighs 1 gram) to 1000 grams, and secure a total weight of 1047 grams.**

Tempering Is Important

For the tempering operation, spread the sand on a glass plate in a layer about 1 inch thick, sprinkle a small quantity of the required water evenly over the sand, and work the latter gradually into a heap by rubbing it vigorously through the hands. Again spread it into a thin layer and repeat the above operations, adding more of the water. Continue to do this until all of the water has been thoroughly distributed through the sand. There should be no dry lumps or other evidence of uneven tempering.

The sand should now be allowed to stand in order that the maximum temper may be developed. To secure this temper, place the sand in a humidor or air-tight receptacle, and allow it to stand for 24 hours. After this the actual work of testing shall be carried out as indicated in the following sections.

Pass the entire sample of sand twice through a coarse riddle, and return the sand as quickly as possible to the humidor or receptacle. Next determine the moisture content as follows: Dry 100 grams of tempered sand for 1 hour at 105 degrees Cent., with a tolerance of 5 degrees. When dry, reweigh. The loss of weight in grams is the moisture content expressed as percentage. When determining the permeability of sand having a definite moisture content, a deviation not exceeding 0.2 per cent from the desired water content is permissible. For example, sand intended to have a moisture content of 6 per cent must have an actual moisture content of not less than 5.8 per cent or more than 6.2 per cent.

Take a sufficient quantity (from 150 to 200 grams) of tempered sand to make a column 2 inches (5.08 cm) high, with a tolerance of 4 per cent. The sand should be carefully placed in the container, *E*, and gently leveled off. Place pedestal and container with sand in position beneath rammer. Gently lower rammer rod with head into container until they are supported by the sand. Raise rammer head to the upper stop and let fall. Repeat twice, making a total of three rams. Note whether the upper end of the rod is within the tolerance marks. If not, discard the sample and put in another lot of tempered sand of sufficient quantity to yield a column of the required height. This is usually accomplished on the second trial. Lift until entire rammer rod is removed from container, and take container off of pedestal. Place container in permeability apparatus, seeing that the rubber stopper, 8, fits tightly in upper end of container, *E*. Then close tube, 4, with a rubber stopper, 5, or stopcock.

The sand specimen is now to be tested. Turn on water into bottle, *A*, and regulate the flow into this bottle when valve, 9, is open, so that the level of the water in bottle, *A*, will be just sufficient to permit constant discharge through overflow, 1. Open wide valve, 9, permitting water to flow into air displacement bottle, *B*. The rise of the water in gage, *D*, from the mark indicating 2 liters, to that indicating 4 liters, shows a displacement of 2000 cubic centimeters of air in the bottle *B*. With a stop watch prepare to ascertain the time. Determine this at the instant the water level or maniscus passes the 2-liter mark, and again at the instant the water passes the 4-liter mark, noting the number and fractional parts of minutes required for the movement of the water between these two marks. When the water passes the 4-liter mark, stop the water flow into bottle, *B*, by closing valve, 9. While the interval of time is being determined for the movement of the water between the said marks, take two separate readings of the pressure in the manometer, *C*, and record the average. As the observed reading on the manometer scale is only that pressure in one leg of the manometer, multiply this average observed reading by 2, to get the actual pressure of the air on the sand. This is the pressure to be recorded.

To force the air through the same specimen a second time, again let the water into bottle, *B*, by opening valve 9. As the water level passes the 5-liter mark on the scale of the water level gage, *D*, start the timing period, stopping at the 7-liter mark, and repeat the other operations outlined in the preceding paragraph. To obtain more than two determinations on the specimen, open tube at 5, and drain bottle, *B*, and water level gage, *D*, by opening valve 7. When water level has dropped to approximately 1 inch below the 2-liter mark on water level gage, *D*, close valves, 7 and 5. The apparatus is now ready for another test. Make sufficient determinations on the same specimen to obtain at least three pressure readings that are uniform, in which the time does not vary by more than 1 per cent.

Calculation of Permeability

The degree of permeability as determined by this test is found by employing a formula. By its use, permeability is ascertained as the volume of air per minute, per gram per square centimeter pressure, per unit volume in specimen.

Permeability equals the cubic centimeters of air forced through the sand specimen, multiplied by the height of the sand specimen in centimeters, divided by the pressure in grams, multiplied by the area of the sand specimen in square centimeters, divided by the minutes of time. Thus, permeability equals

$$\frac{\text{cm}^3 \text{ of air} \times \text{cm height of specimen}}{\text{grams pressure} \times \text{cm}^2 \text{ area of specimen}} \div \text{minutes}$$

The method of conducting the permeability test herein described calls for 2000 cm_3 of air to be forced through the specimen; 5.08 cm (2 inches) to be the height of the specimen; and 20.268 cm_2 (3.1416 square inches) to be the area of the specimen. These fixed quantities are therefore substituted as constants in an equation as follows:

$$\text{Permeability} = \frac{2000 \times 5.08}{\text{grams pressure} \times 20.268} \div \text{minutes}$$

Reduced to its simplest terms this equation reads:

$$\text{Permeability} = \frac{501.2}{\text{grams pressure} \times \text{minutes}}$$

The Industrial Gloves Corp, announces the removal of its offices and manufacturing departments to its new location, 1213 Fullerton ave., Chicago.

*Drying the sand during the mixing period can be avoided by working the sand in a large tent humidor. The humidor may consist of a water pan 30 inches square and 2 inches deep supported on a wooden frame which is surrounded by previously saturated muslin. The upper edge of this muslin is folded over into the pan of water, and the resulting capillary attraction provides the moisture and the effect of a humidor. Do not leave sand in the tent humidor after mixing, as some sands may absorb additional moisture from the tent atmosphere.

**Moisture content for all molding sand determinations and tests is to be expressed as the percentage of moisture in the *damp* sample of sand. It is not proper to calculate the amount of moisture, proportionate to the weight only of the dry sand.

Dayton Firm Acquires Buffalo Plant

Sale of the Pratt & Letchworth Co., one of the oldest manufacturing concerns in Buffalo to the Dayton Malleable Iron Co., Dayton, O., was announced recently. By this merger, the Buffalo foundry becomes a unit in one of the largest foundry organizations in the country devoted to the manufacture of malleable, gray iron and steel castings for the automotive industries.

The present officers of the company will be retained with John C. Bradley, chairman of the board of directors. The capacity of the Buffalo plant is 40,000 tons a year. More than 1500 men are employed.

Matthew F. Gartland, president of the Gartland Foundries Co., operating 11 malleable and 6 gray iron foundries in Ohio, Indiana, Illinois and Missouri, including the Dayton company, closed the merger.

The Pratt & Letchworth Co., is 75 years old, having been founded in 1848 by Samuel F. Pratt, Pascal P. Pratt and William P. Letchworth for the manufacture of saddlery and carriage hardware. The business has increased until it has become one of the largest manufacturers of railroad castings in the country.

Cadillac Will Build New Foundries

The General Motors Corp., announces that three foundry units are to be added to its Cadillac division in Detroit. The new foundry units are to produce gray iron, aluminum and brass castings. With the completion of the new units the Cadillac plant will have a foundry equal in capacity to its main plant production and will match the main plant in efficiency and layout. H. B. Swan is foundry manager.

Chilled Tread Wanted on Small Wheel

Question: We are enclosing a blue print of a small double flanged truck wheel with a chilled tread. The castings are ordered in quantities of 50 and 100 and vary in size from 7 to 12 inches diameter, and, therefore, while the job would not justify the installation of elaborate rigging, still it is of sufficient importance to lift it out of the odd-job class. The wheels must be poured with fairly soft iron on account of the necessity of boring the hub to 1⅞ inches. We would like to learn how to chill the tread and still retain a smooth, true, circular face on the casting. Apparently it will be necessary to apply the chill in segments and as a result the casting will present ridges at the various joints. We have no objection to chilling any other part of the casting if by so doing a workable method is presented for chilling the tread in the manner outlined.

Answer: Three satisfactory methods

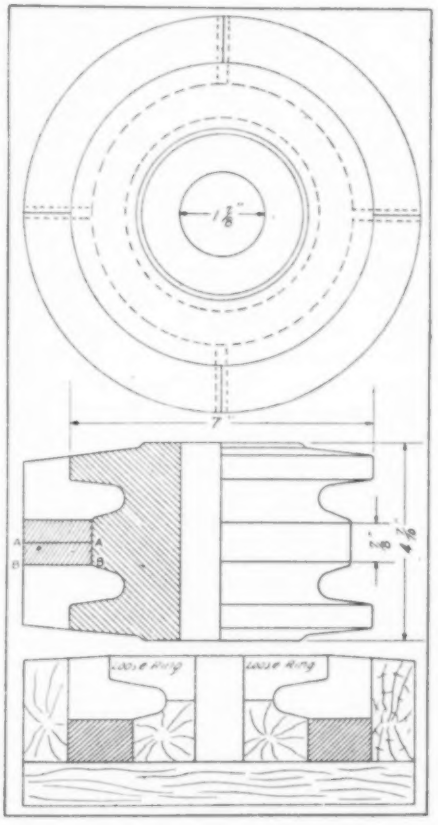


FIG. 1—PLAN FIG. 2—PROFILE AND SECTION OF WHEEL FIG. 3—SECTION OF COREBOX WITH CHILL IN PLACE—WHEN MAKING THE UPPER HALF OF THE RING CORE THE CHILL IS REPLACED BY A SUITABLE FILLING-IN PIECE

are available for making this wheel and the adoption of one in preference to the others will depend on circumstances.

(1) A permanent mold may be employed split in the center vertically, one half attached firmly to the base plate and with the second half movable. Considerable expense is involved in the preparation of a mold of this character, but on a production basis it is the cheapest of any.

(2) By substituting a piece of heavy steel tube for the center core, the casting may be poured with hard iron and, therefore, obviate the necessity of chilling the tread. With ordinary care the tube will not vary more than 1/16-inch from the center and the hole easily may be trued on a lathe or boring mill if necessary. When made in this manner the grooves on the outside are formed in a one-piece, dry sand ring core.

(3) In the third method the outside is formed in a dry sand ring core with several sections of chill bedded in the core at what may be termed the equator. It will be noted in Fig. 1, that while the dry sand core is in the form of a continuous ring, the chill segments are separated by approximately ¼-inch. A chill made in two sections could be removed from the casting, but after it had been used a few times it no longer would be true. Intermittent heating of the inside would distort it. A chill made in four sections will not warp to any great extent and if it does it readily may be trued on the emery stone. A two-fold purpose is effected by the ¼-inch opening between the ends of the segments. It provides room for expansion and the body of sand in the opening prevents any ridge forming on the casting at the junction of the segments.

If the third method is adopted it will be necessary to provide a ring corebox differing slightly from the corebox employed in the second method. In the second method a single corebox makes two half cores which then are joined and pasted on the line, *AA*, Fig. 2. In the third method the corebox is extended to the lower line, *BB*. The chill sections fit snugly in the extension, the remainder of the box is rammed full of core sand, rolled over on a plate and when the box is removed the chills remain on the core and are dried in that position. A suitable filling-in piece then is placed in the extension chamber in the box, it again is filled with sand, rammed and rolled over on a plate. When both cores are dried they are pasted in the form of a sandwich with the chills between an upper and lower layer of sand.

Open New Offices

The Whiting Corp., Harvey Ill., has opened a district sales office at 624 Penton building, Cleveland, R. P. Dryer is district manager. This office will represent the Whiting Corp. and its subsidiaries the Swenson Evaporator Co., and the Grindle Fuel Equipment Co.

The Niagara Falls Smelting & Refining Corp., Buffalo, has started the first unit of its plant on the production of brass and bronze ingots for special alloys. Ernest G. Jarvis is vice president and general manager.

L. M. Dalton has been appointed manager of the Boston office for the Link-Belt Co., Chicago and Philadelphia. Mr. Dalton succeeds E. J. Burnell resigned.

The Tropenas Co., engineers, has removed its office to 2236 Cunard building, 25 Broadway, New York City, discontinuing its Brooklyn office.

Recalls Curious Experience

Old Time Foundry Equipped with Made-to-Order Machinery Operated Two-Horse Power Unit Driving Blower and Mills —Made Bells from Scrap

BY ROBERT E. MASTERS

IN THE distant past a foundryman who considered himself too old to work regularly and longer in his little shop made me a proposition to run it on shares. The shop was located in a prosperous district and since I was sure that I could earn at least as much as the average day's pay in other shops and also have my own way, we easily came to an agreement. I do not think there ever was or ever will be another shop like that one, but some young man of limited means, ambitious to have a business of his own may derive some benefit from the following description.

The foundry, like the Irishman's shanty, had all three rooms in one and there was nothing to indicate where one department left off and another began. The combination of molding floor, melting and cleaning departments covered a floor space 35 x 40 feet. A stock yard 10 x 35 feet across one end was taken up with pig iron, scrap and coke bins and the other miscellaneous material that collects around a foundry.

Inside the foundry I could reach up and touch the roof at any point except possibly in the center. The cupola was made in two sections of cast iron staves 4 inches wide, 4 feet long provided with lugs top and bottom to hold a band with other lugs to bolt the sections together. The upper section stuck out through the roof and two holes were left at two points, one for the breast and the other for a charging door. The shell rested on a bottom plate provided with a drop bottom and the plate in turn rested on two brick walls. The cupola was lined to 18 inches and was picked out and daubed for a heat through the large breast opening and also with a long bar from the charging door. It was too small inside for a man to work.

Use Home Made Equipment

The home made, cast iron, round-bottom ladles had a capacity of 100, 200 and 300 pounds respectively. The shanks were quite loose and were adjusted with gaggers or iron wedges to keep the ladles steady. The tumbling barrel was made from staves similar to those in the cupola and was located right beside the fan so that the motive power readily could be switched from one to the other.

Two-Horsepower Fan

The power for operating the tumbling barrel and fan was furnished by a pair of big draft horses that were available any time on 24 hours' notice. They were hitched to a *merry-go-round*, two for the fan and one for the tumbling barrel. The fan was a galvanized iron casting provided with four plain blades and delivered air through two combination tin and leather tuyere pipes that could be bent around to suit varying conditions. With proper connections and the animated motor functioning smoothly we could get all the air that was necessary and the cupola certainly produced hot, clean iron. In fact at times it came too hot and too fast and our only remedy was to stop the 2-horsepower motor for a short time. We fitted up a big cook stove that came in the scrap to make an efficient core oven. It was planted outside the door and equipped with one length of pipe.

In my own person I constituted practically the entire operating, supervisory, administrative and clerical force. We had no pattern shop and had to improvise continually for incoming jobs. At times it seemed as if people around the country broke odd shaped castings in an effort to find something that we could not make. A small machine shop in the town stacked up 55-45 with the foundry and we helped each other.

A collection of pulley and gear patterns up to 36-inches diameter afforded me an opportunity of practicing tricks to which I had been accustomed in my apprentice days in the sixties when I made gears and pulleys wider and narrower than the pattern or swept and cored them for single or double arms.

One day a customer brought in an old greasy 22-inch pulley with a piece broken out of the rim and with one arm missing. He wanted a new casting and refused our offer to supply either an 18 or 24-inch size for which we had regular patterns. We threw the old castings in the fire and burned off all the grease and while it was hot we beeswaxed the surface and also made a temporary arm and a close fitting lifting plate for the inside.

The pattern was set on a level bed and filled with sand up to the arms. The cheek and lifting plate were adjusted and sand was rammed to the top of the pattern. A strip of cardboard was fitted around the rim, partly to compensate for contraction and partly to close the gap in the rim. A plain cope was rammed and lifted off and then the cheek was wedged up slowly and removed from the pattern. By rapping the pattern all around we secured a passable lift on the inside. The mold was patched and reassembled and produced a creditable casting. With the help of the 55 per cent machine shop it was made quite presentable.

Among other castings we made mold boards and plow points. When a new style appeared we secured sample castings and soon fitted them to serve as patterns. We also had a fine trade on 100-pound farm bells and 200-pound school and church bells. I charged the cupola, tapped it and poured the metal with the aid of a boy on the stem end of the ladle. The iron charged for bells was made up of the hardest scrap and worst junk we could pick up, old sleigh shoes, burnt grate bars, in fact anything.

Improvised Patterns

We poured the bells through a whirling skim gate core and I never knew one of these bells to have slag or dirt in it. The bell charge in the cupola was preceded by a good charge of gas-house coke. I also placed some sulphur in each leather tuyere from where it blew in slowly. The resulting metal was like silver, close and white and no bell ever had a clearer or more musical ring.

The most peculiar job I ever was asked to make was brought in one day by a man who had lost his left

arm at the wrist. He asked me if I could use his arm as a pattern to form an iron casting which he could use later as a mandril on which to shape a light copper casing to serve as an artificial hand and arm. I assured him the plan was quite feasible. I cut a hole at the joint of a cope and drag so it would fit easily over the arm. He was as hairy as a gorilla and before starting to make the mold I shaved the *pattern* up to the elbow. I elevated the drag so that the owner of the pattern could sit comfortably during the operation. The arm was bedded in and the sand was tucked carefully so that the mold would be firm and at the same time I had to proceed cautiously so that the shape of the arm would not be distorted. After the cope was rammed and lifted off I sponged around the arm and lifted it out of the drag, then closed the mold and poured it. He was pleased with the casting and the manner in which he rigged the new copper arm to hold tools was astonishing. I have seen him carry a bucket of water as satisfactorily with his repaired arm as he could with the other. A lifetime spent around a foundry has afforded many unusual experiences.

Casting Demand in Cement Industry

BY GEORGE S. EATON

A GROWING source of demand for castings, both iron and steel, is emphasized by the production figures on portland cement for the first three months of 1923, recently published. When operating steadily, the cement companies must make large purchases of repair parts. Wear on the many pieces of heavy machinery required in manufacturing cement is unusually rapid, because of the hardness of the substances to be crushed and ground and the great volume of material handled.

The use of cement in concrete roads and all classes of structures involves the purchase of a great amount of equipment, and also many parts for repairs from time to time. Reference to the U. S. census bureau's reports on the machinery output for different purposes shows that in the seven-year period from 1914 to 1921, the value of the miscellaneous road-building equipment increased from $3,545,000 to $17,858,000. Concrete mixers, which are listed separately, show an increase in value from $2,956,000 to $8,666,000 in the same period. Of course, castings enter largely into all this machinery.

Increase Shown

Starting 1923 with a production of 49,938,000 barrels, an increase of 40 per cent over the 1922 output for the same period, the cement plants bid fair to turn out a considerably larger total for the year than the record output of 114,790,000 barrels for 1922. Not only has the demand for castings increased as a result of the activity in cement manufacturing, but a noticeable tendency has developed toward the adoption of steel castings because of their greater durability. Even in cases where the longer life secured in this way is not sufficient to show a saving in itself, the avoidance of shutdowns for replacements often will justify the greater initial cost. Time is now more than ever a matter of first importance in cement mill operation and maintenance.

Among the many parts frequently requiring repair or replacement are the following: Rolls for centrifugal grinding mills, sprocket wheels, pulleys, bearings, lining plates for various pulverizing machines, chain links, kiln gears, and jaw plates for crushers. Of these, the lining plates are now commonly chilled iron or cast steel; the rolls, manganese steel castings; the links, malleable iron; the kiln gears, cast steel; and the other castings usually are gray iron. To avoid costly delays when breakage occurs, spare parts must be kept in stock for nearly every piece of equipment. One company's inventory of extra parts runs as high as a million dollars.

Cement making requires not merely one or two crushing and grinding operations, as many suppose, but instead it calls for eight different stages in all in preparing the raw materials for burning, in pulverizing the coal for the kilns, and in powdering the clinker to make cement. The result is that the cement mills are filled with heavy machinery.

With the change from cast iron to cast steel in order to secure the desired strength and durability, difficulty sometimes arises because of failure to heat treat the castings properly. Doubtless this has been due in part to the feeling that because the casting was made of steel instead of iron, it inherently had the desired strength, with the result that no adequate check was secured upon the analysis of the casting nor upon its annealing.

NEW CASTINGS FOR GRINDING EQUIPMENT IN A PORTLAND CEMENT PLANT SHOWN AT THE LEFT; WORN CASTINGS AT THE RIGHT

Several such breakages have occurred with the giant jaw crushers that have been installed by a number of plants. Until a few years ago, crushers were comparatively small, but now they are built with openings up to 5½ by 7 feet. On these huge machines, one or more steel castings replace the cast-iron frame used on the smaller sizes. In one case, during operation, a crusher broke in

which the frame was 20 feet long and the cross section of the steel was about 6 inches by 5½ feet. From the appearance of the fractured member, it was evident that the casting had never been properly annealed before initial assembly.

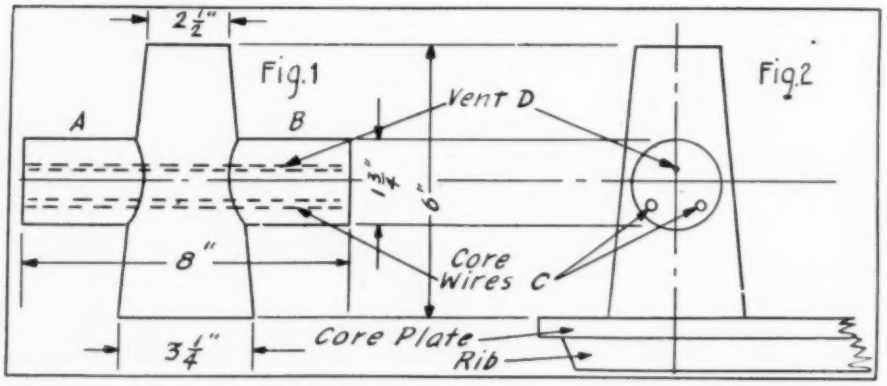
To avoid expensive breaks such as this, the manufacturers have learned the necessity for careful inspection of the annealing process at the foundry, followed by the testing of coupons cast with the piece and annealed with it as integral parts. With proper treatment, the full advantages of the more durable steel castings can be insured without a doubt.

Small Valve Cores Require No Dryers

BY M. E. DUGGAN

CORES for small valves are made after several methods depending in individual cases on the personal judgment of the coremaker or the patternmaker who designs the rigging.

Once a method has been established it is only rarely that any person has the temerity or initiative to propose a change. During the experimental stage the core shown in the accompanying illustration was made in a half corebox, dried and pasted. Later this and nine other sizes of the same valve were placed on a production basis and it became necessary to provide equipment for that purpose. The foundry foreman decided on the style of pattern required and the core room foreman was of the opinion that a whole box and a set of dryers was the most economical equipment for making the cores. To that end he had 10 sets of dryers made, one set for each size core and 12 dryers to a set. Where this equipment did not meet requirements he had additional dryers made. He was crowded for space in the core oven and only a limited number of cores of any one kind could be baked at one time.



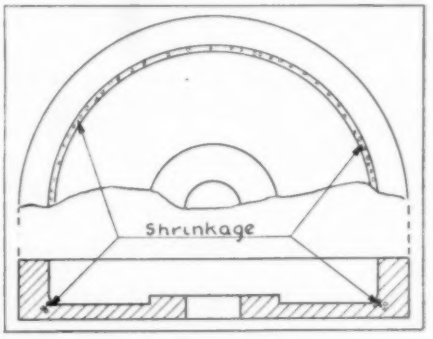
INSTEAD OF USING A DRYER THE CORE WAS PLACED ON END ON A PLATE

Eventually the valve business increased and it became necessary to put a second coremaker to work on the job. In a short time he discovered that the cores, large and small, could be placed upright on an ordinary core plate and baked in that position. In this way he found that one plate would hold more cores than a dozen plates under the old system.

The side members *A* and *B* are supported by the wires *C*. Wire of varying diameter, straight and cut to the exact length are employed for the purpose. Wire ⅛-inch diameter is used in the smaller cores, 5/32-inch for the medium size and ⅛-inch for the larger size. The wire is straightened, cut to size and kept in cigar boxes on the coremaker's bench. The corebox is open at each outlet and two wires are inserted approximately in the position shown in the illustration after the box has been rammed full of sand. The core is vented after the wires have been inserted. One half of the corebox is removed, the second half containing the complete core is placed in an upright position on the core plate and then the second half of the corebox is withdrawn laterally, leaving the core upright on the plate and close to the core which preceded it.

Limitations Encountered in All-Purpose Iron

That the common and sensible practice of using a standard charge for different classes of work in the same foundry has its limitations, is proved again by the example in the sketch. The company's tonnage was about evenly divided between stove plate castings and automobile work. Among the latter class was a fair proportion of fly wheels and, as the plant was operating at only about half capacity, the iron required for the day's production was melted easily during a couple of hours in the afternoon. Molders poured any mold at any stage of the heat, providing the metal was of sufficiently high temperature. This procedure was followed as it was necessary to get the iron away from the cupola as fast as it melted.



WHERE SHRINKS WERE FOUND

Sponginess developed in the heavy section of the flywheels immediately beneath the skin at the fillet, due, evidently, to the high silicon, low manganese mixture necessary for the stove-plate castings. The shrinkage was spread around the entire circumference in every instance. The best way to remedy the difficulty in this and similar cases seems to be to line down the cupola to a smaller diameter and slower melting capacity. This prolongs the heat, and the foundry may be operated on a semicontinuous basis.

Melting Wrought Scrap

By H. E. Diller

Question: Kindly tell us how to melt wrought iron scrap so that it can be made into castings which have the same properties as the original wrought iron. We have tried to do this but found that the casting crumbled readily under heat and would not forge.

Answer: It would be impossible to melt wrought iron scrap and cast it so as to retain the same physical properties as it had before casting. Wrought iron is an almost pure iron, containing particles of slag, which gets its peculiar properties from the way it is piled and

rolled. Also, the fact that it has a low percentage of carbon would make it difficult to cast.

However, melted with a small percentage of pig iron in an electric or open-hearth furnace and the usual additions of ferromanganese and ferrosilicon it could be made into low-carbon steel castings which would be soft and ductile.

British Rollover Unique

FOR handling medium size two-part jobs where the cope and drag are different, and for other work, a duplex rollover molding and core machine has been developed recently by the Adaptable Molding Machine Co., Birmingham, England. Some features of this machine are shown in the accompanying illustrations. The device, as shown in Fig. 1, consists of a heavy cast-iron pedestial carrying a horizontal shaft at the top, on the ends of which the pattern drawing and flask holding mechanism is mounted. The machine is designed for hand ramming. Each unit operates independently of the other and the load can be adjusted centrally thus effecting an even balance for rolling over.

Referring to Fig. 1, the swinging arms for clamping the work travel up and down on long guides *1*, the arms being placed in the position *2* for clamping the flask and forming the draw table. The trunnion center *3* is 2 feet 8 inches from the floor line. The pattern plate *4* is fixed to the swing arms as shown, forming a table to receive the flask, the drag in this case being made at the right and the cope at the left. The finished drag and cope are shown in the foreground, the flasks, which are rolled steel, being 12 x 21 inches with the drag 4 inches and the cope 13 inches in depth. The cope weighs 245 pounds rammed up and the drag 79 pounds. The machine shown will take a flask 20 x 30 inches and any depth not exceeding 17 inches with a maximum load up to 450 pounds.

A front view of this machine rigged for another job is shown in Fig. 2. In this case a double-sided pattern or match plate is used, the adaptor brackets *3* being provided to hold the cast-iron match-plate *4*. The flask is cast iron 14 x 18 inches inside, the drag being 4 inches and the cope 7 inches in depth. The distance between the centers of the flask pins is 23 inches and the lugs are so designed that they also form the handles by which the flask is lifted. The pattern plate is 25 inches long between the brackets, 15 inches wide and ¾ inch thick. The finished cope mold is shown in front of the machine, the drag being seen resting on the swing arms in a drawn position.

The two guides which carry the swing arms are 3 feet 6 inches in length overall and 15 inches apart. A spring plunger *2* definitely locates the swing arms in both positions. The cross frame is provided with an adjusting slot *7* for varying depths of flask. When brackets such as shown in Fig. 2 are employed, flasks up to 22 x 24 inches can be employed. The pattern is drawn by operating the star wheel *6*, Fig. 2.

The operation of the machine is as follows:

1. Place flask on pattern plate
2. Put in sand and ram up mold
3. Close swing arms over flask
4. Lock swing arms by means of star wheel holding the flask to the pattern plate while rolling over
5. Release index pin and rotate 180 degrees when it automatically locks the frame in the position ready for drawing
6. Operate the star wheel which simultaneously raises the pattern plate and lowers the flask until the ·tter is ready for removal
7. Release index pin and bring machine back to original ramming position.

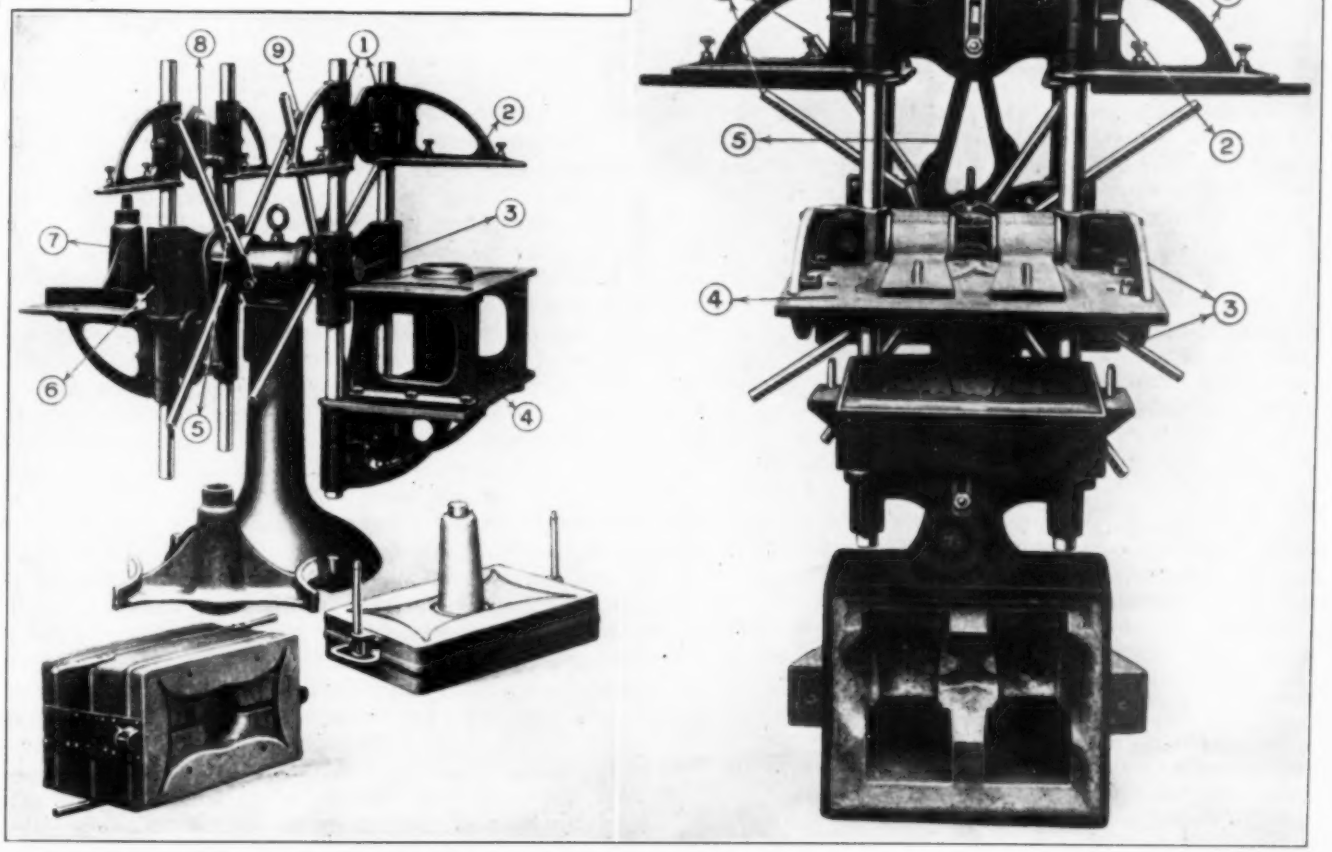


FIG. 1—GENERAL VIEW OF DUPLEX ROLL-OVER MACHINE RIGGED FOR HANDLING A TYPICAL JOB FIG. 2—FRONT VIEW SHOWING MACHINE RIGGED FOR USE WITH MATCH PLATE

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Steel Castings Pass Million Mark

RECOVERY and increased production are registered in the steel castings branch of the foundry industry, as attested by the figures for the total output in 1922. Although the entire industry suffered severely from the depression, it is apparent that steel foundries were the hardest hit of any castings manufacturers during the slump in 1920-1921. The entire output for 1921, as was noted previously was only 559,713 tons, the lowest total reported since 1909. The complete and satisfactory recovery is indicated by the 1922 production of 1,034,508 tons which is greater than any year since the outbreak of the European war. A better basis of comparison is afforded by comparing this 1922 output with the average of several years. Regarding that interval from 1915 to 1918 as the war period, the average production of steel castings was at the rate of only 1,271,851 tons per year, despite the tremenduous demands of war service which marshalled the entire steel foundry capacity of the country and forced a tremenduous expansion of manufacturing facilities. The post-war period, covering 1919-1920-1921, when industrial activity brought heavy requirements for steel castings produced an average of 929,231 tons per year output. Of course, this interim includes the peak of prosperity and the depth of depression, but this average falls short 105,277 tons of equalling the production of 1,034,508 tons reached during the past year. The difference shows an increase of almost 11.5 per cent over the post-war average output.

The increase shown in the total for 1922 over the previous year, carries through in practically all classes of steel castings. Open-hearth castings produced in 1922, totaled 830,748 tons, compared to 434,445 tons for the previous year. This was 235,694 tons below the average during the war period and was 102,960 tons ahead of the period from 1919 to 1921 inclusive. This shows a gain of over 14 per cent over the post-war time. Of the 1922 total, basic shows 425,981 tons and acid 404,767 tons.

Bessemer steel castings totaled 47,733 in 1922. Although this is an increase over the preceding year, it is 91,113 tons less than war time production and 33,036 tons below the average of 1919-1921 inclusive. Bessemer steel reached its high point in 1912 when a total of 20,550 tons are shown, and since that time the output has decreased steadily, except for a slight recovery in 1915. High prices, coupled with the difficulty of securing the bessemer grades of iron with the low phosphorus and sulphur content are largely responsible for this trend, although the development of the electric furnace for use in medium and light weight casting plants has played a part.

Electric furnace castings, showing a total of 154,982 tons, approach closely to the largest tonnage ever made, the 155,196-ton record of 1920. Last year's production was 95,197 tons ahead of the war years and 37,715 tons over the post-war average. The increase is 32 per cent of the average year's production noted for the three years which is 117,267 tons. During the past year slightly under 15 per cent of the steel castings produced in the United States were made in the electric furnace. In 1920, electric steel castings formed 12.4 per cent of the total and in 1909, the first year when a record was made, the 306 tons of electric steel castings constituted only 0.04 per cent of the entire output. Crucible steel castings totaled 1045 tons in 1922, slightly under average.

Trade Outlook in the Foundry Industry

ALTHOUGH midsummer approaches, the customary lull in foundry activity has not appeared. Production of castings is slightly above normal and demand has not been curtailed in any of the main lines of consumption. Railway purchases have taken on new strength in early July, automobile requirements continue, cast pipe sales are adequate to assure full time operation to the remainder of the year and jobbing foundries keep busy on the continued small repeat orders which occupy their floors to the maximum of capacity with the available supply of labor. Labor shortage continues, but is slightly alleviated during the past few weeks.

Automotive Prospects

Manufacturers of passenger automobiles state that a slight overproduction is in sight on open models, but that their maximum output of closed cars will be absorbed for the remainder of the year. In consequence no slackening is apparent in automotive castings production. A few favored manufacturers are pushed to top speed to meet the demand and these, many of which operate their own foundries through excess requirements furnish employment for a great number of jobbing shops. While stove and furnace dealers are experiencing their customary seasonal dullness, foundries making castings for all classes of heating are busy. Present orders in practically all instances are sufficient to engage the entire stove, radiator and furnace casting capacity for the remainder of the year. Machine tool sales are slow and a consequent slackening is apparent in the jobbing foundries making the heavier castings for this branch of industry. However, woodworking machines are in demand, although inquiries are lighter. Some foundries making this class of castings report sufficient orders on hand to occupy them for the remainder of the year on a full time basis.

Prices of Raw Material for Foundry Use

CORRECTED TO JULY 12

Iron		Scrap	
No. 2 Foundry, Valley	26.50 to 27.00	Heavy melting steel, Valley	20.75 to 21.00
No. 2 Southern, Birmingham	25.00 to 27.00	Heavy melting steel, Pitts.	18.50 to 19.00
No. 2 Foundry, Chicago	28.00 to 28.50	Heavy melting steel, Chicago	17.00 to 17.50
No. 2 Foundry, Philadelphia	27.76 to 28.13	Stove plate, Chicago	16.50 to 17.50
No. 2 Foundry, Buffalo	26.50 to 27.00	No. 1 cast, Chicago	23.00 to 23.50
Basic, Valley	25.00	No. 1 cast, Philadelphia	20.00 to 21.00
Basic, Buffalo	25.00	No. 1 cast, Birmingham	20.00 to 21.00
Malleable, Chicago	28.00 to 28.50	No. 1 cast, Buffalo	20.00 to 21.00
Malleable, Buffalo	26.50 to 27.00	Car wheels, iron, Pittsburgh	22.00 to 22.50
Coke		Car wheels, iron, Chicago	21.00 to 21.50
Connellsville foundry, coke	5.25 to 6.50	Railroad malleable, Chicago	23.00 to 23.50
Wise county foundry, coke	7.25 to 7.75	Agricultural mal., Chicago	22.00 to 22.50
		Malleable, Buffalo	21.00 to 22.00

Implements Move Slowly

While retail sales of farm implements are reported as satisfactory, jobbers are buying cautiously and stocks are low. This is due in some measure to the usual summer lull, but at the same time manufacturers realize that with prevailing low prices for farm products, implements will be purchased only when urgently needed. The farm buying power is estimated at 69 per cent of pre-war normal, and sales at 50 per cent of the average maintained previously. However, the labor shortage which is acute in some sections is bringing a volume of business well in excess of that which was available in 1921 and 1922. Crop prospects promise a large sale of reaping and threshing machinery. Truck sales in rural communities are large, but tractor demand still is lagging. Cast iron pipe, soil pipe and fittings foundries have a fair tonnage on their books and are operating at their best possible capacity with the available labor supply. This latter is slightly improved, one eastern pipe foundry which a month ago was limited to 60 per cent of capacity has increased its rate of operation to about 80 per cent.

Little Iron Sought

Despite the heavy production of pig iron which obtains at present, and the consequent weakening in prices, foundries are not buying beyond their immediate requirements. Some shops have practically no iron contracted for delivery beyond July and will have to enter the market for even their August and September metal. Consequently buying is expected to develop within the next two or three weeks. The output of pig iron showed a drop in June, according to statistics, compiled by the IRON TRADE REVIEW. This is the first recession noted since the upward trend set in last September. The total production of pig iron for June was 3,673,503 tons, or 194,983 tons less than the May output of 3,868,486 tons. The daily average for June was 122,450 tons while for the previous month it was 124,790 tons. The production of merchant iron is given as 898,811 tons for June, showing a loss of 10,915 tons when compared with the May total of 909,726 tons. On a daily average basis, June registered slightly above the previous month with an average of 29,960 tons per day compared with 29,346 tons for May. Shipping conditions are extraordinarily good. Despite the heavy loadings of freight cars, traffic is handled expeditiously. The railroads loaded 1,021,770 cars of freight in the week ending June 30. This constitutes a new high record and it was established at a time when the net average of surplus cars was 52,000 per day. Frieght car repairs are lower than ever before, standing on June 15 at only 8.9 per cent of the total number of cars on the road.

Nonferrous Prices

Nonferrous prices according to New York quotations in the *Daily Metal Trade* of July 12 follow: Castings copper, 14.37½c, electrolytic copper, 14.62½c, to 14.75c; Straits tin, 38.37½c; lead, 6.00c; antimony, 6.75c to 6.80c; aluminum, No. 12 alloy, open market, 23.00c. Zinc is 6.15c to 6.20c, E. St. Louis, Ill. Monthly average prices for June follow:

(New York Quotations)

Casting Copper	Electro Copper	Lead	Tin Straits	Antimony	Aluminum 98-99	Zinc St. Louis
14.604	15.011	7.17	40.55	6.87	26.00	6.043

Comings and Goings of Foundrymen

C. R. MESSINGER, vice president and general manager of the Chain Belt Co., Milwaukee, since 1917, has been elected president, succeeding William C. Frye, who has given up active business pursuits. Mr. Frye has retired after an active association with the company for 28 years. During this period he held practically all of the important executive positions and at the time of his election to the office of president in 1916 he was treasurer of the company. Under his leadership the company continued the steady growth inaugurated by C. W. Levally, its founder and first president, and today it is one of the largest producers of chain, concrete mixers and conveying machinery in the country. Mr. Messinger became associated with the Chain Belt Co. in 1917 after serving eight years as general manager of the Sivyer Steel Casting Co., Milwaukee. Mr. Messinger also is president of the Interstate Drop Forge Co., vice president of the Sivyer Steel Casting Co., and the Federal Malleable Co., all of that city, and is a director of the Nugent Steel Castings Co., Chicago, and the First Wisconsin National Bank of Milwaukee. Mr. Messinger is a past president and a director of the American Foundrymen's association, and is prominent in the affairs of the American Malleable Castings association.

George E. Waller, who has been office manager of the Wilson Foundry & Machine Co., Pontiac, Mich., has been chosen secretary. He succeeds Earl MacKenzie, resigned.

H. C. Smith, former president of the Allith-Prouty Co., Danville, Ill., it is understood will be selected to head the new company which is being formed to operate the foundry of the Moline Plow Co., at East Moline, Ill., which recently was acquired by Chicago and Danville interests. Mr. Smith in addition to being a former president of the Allith-Prouty company, also is a former president of the Danville Foundry Co. Other members of the company being organized are O. J. Failing, Frank Mancan and E. M. Richardson, all formerly connected with the National Malleable Co., Chicago, in executive capacities.

Charles S. Boardman at a recent meeting of the board of directors of the Strong Steel Foundry Co., Buffalo, was elected vice president and manager of sales. Mr. Boardman, who has always followed engineering work, is a member of the American Society of Civil Engineers. He was made designing and construction engineer with the Lackawanna Steel Co. in 1901 when that company had started construction of its plant at Buffalo. Upon its completion, Mr. Boardman became affiliated with a concern which later was known as Conkling & Boardman, consulting engineers. In this connection he served as engineer for several steel interests in and near Buffalo. During this time Mr. Boardman invented and patented what is now known as the Lackawanna Steel Co. sheet piling. In October, 1913, Mr. Boardman returned to the Lackawanna Steel Co. as engineer of the steel sheet piling department. In October, 1922, upon the purchase of the Lackawanna Steel Co. by the Bethlehem Steel Co., Mr. Boardman continued in the same capacity, resigning recently to take up interests in the Strong Steel Foundry Co.

Retires From Business

U. E. Kanavel has disposed of his interest in the Peerless Sand Co., Conneaut, O., and has retired from active business because of ill health. Mr. Kanavel has been affiliated with the molding sand business for 35 years. He gained his first experience at Zanesville, O., where he was connected with the Ayres Mineral Co., for 18 years, and later he was manager of the Interstate Sand Co., Cleveland, for a period of 6 years. Prior to the incorporation of the Peerless Sand Co., 5 years ago, Mr. Kanavel was affiliated with the Gordon Sand Co. of Conneaut.

Hold Summer Outing

The midsummer outing of the New England Foundrymen's association was held at The Hummocks, Hamilton, R. I., Thursday, July 12. Providence members of the association acted as hosts and a clambake and various sports engaged the attention of those who attended. Edward F. Parks, Universal Winding Co., Providence, was chairman of the committee on arrangements. A. J. Miller, Whitehead Bros. Co. and C. H. Colvin, Colvin Foundry Co. had charge of the indoor and outdoor sports. Charles T. Colvin presided over the entertainment features while W. Scott Thomas, J. W. Paxson Co., had charge of transportation.

Obituary

Clinton H. Meneely, president of the Meneely Bell Co., of Troy, N. Y., died at his home here, aged 86.

John J. Gross, a supervisor in the plant of the Doehler Die Casting Co., Brooklyn, died June 2, at his home in Brooklyn.

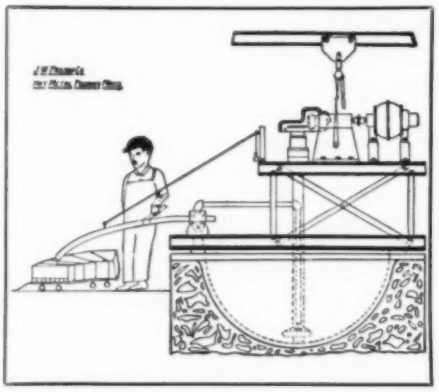
Henry Southworth Shaw, aged 90 years, president of the Saco-Lowell Shops, Boston and former president of the Eastern Machinery Co., and the Rhode Island Malleable Iron Works, Hills Grove, R. I., died at his home in Milton, Mass., June 1. He was for a short time president of the Boston & Maine railroad and had been identified with many other business interests.

John P. Whelan, treasurer the Western Foundry Co., Chicago died at Beverly Hills, Cal., June 17 and was buried in Cleveland June 23. The late Mr. Whelan was connected for many years with the Clinton Oil Co., and the Canfield Oil Co., Cleveland and was serving as treasurer of the latter company when he resigned in 1906 to become treasurer of the Western Foundry Co., Chicago. His health has been impaired for the past two years. He is survived by a widow Mary V., and a daughter Mary Alice, also by a nephew Edward J. Kilfoyle who has made his home with him for the past 20 years.

Dyke Williams late president of the Galesburg Malleable Castings Co., Galesburg, Ill., died in Los Angeles, April 8. The late Mr. Williams was born in Auburn, N. Y., in 1857. As a young man he became identified with the Link-Belt Co., Chicago, and remained as treasurer with the company for 22 years. In 1907 he organized the company with which he remained as president and general supervisor until his death. He was a member of the Midlothian and Union League Club, Chicago and the Galesburg Club, the Country Club and the Kiwanis Club, Galesburg, Ill. He was married on June 22, 1893 to Harriet S. Williams, Buffalo who survives.

Develop Metal Device for Pouring

An outfit for handling hot metal direct from the pot or cauldron by a motor driven centrifugal pump has been devised by the J. W. Paxson Co., Philadelphia. The hot metal is pumped directly from the pot to the molds as is shown in the accompanying illustration. An attendant guides the spout from one mold to the next until the pot has been emptied. The outfit being portable, can be put to one



PORTABLE MOTOR DRIVEN HOT METAL PUMP

side until another set of molds is ready or another pot full of molten metal is prepared to pour.

Among the advantages claimed for the rig is that it does away with the hot work of dipping the molten metal from the ladles and filling the molds, as is commonly done when handling the softer metals such as lead, zinc, tin and spelter.

It is stated that the company is already making installations. A water-cooled mold has been developed by the Paxson Co. and the two are said to work together to advantage

Feeding Heads Not Necessary

(*Concluded from Page* 561)

runners, propellers and other castings which must be clean and solid.

It is possible, indeed quite probable that among readers of THE FOUNDRY men are thinking and studying along the lines touched upon in this article. Probably other foundrymen are pouring castings successfully in a similar manner. Scientific men no doubt in time will arrive at a conclusion concerning the fundamental principles which make it possible to cast metal without feeding heads or risers.

No opportunity was afforded to apply the pressure system to manganese bronze castings and therefore no results can be presented in relation to that metal. However, the method was tried with aluminum bronze, a metal which resembles manganese bronze in many respects but in which the shrinkage factor is more pronounced. Recently a thrust washer was cast from this metal 28½ inches outside diameter, 17½ inches inside diameter and 1⅛ inches thick. The job was molded flat in a 42-inch square flask in the ordinary manner, then closed and turned up on edge and poured in that position through a long gate that extended from 27 inches above the top to the bottom of the casting. When the casting was taken from the sand scarcely a blemish showed on the surface and when it was machined the surface was as clean and smooth as a mirror.

Editor's Note:

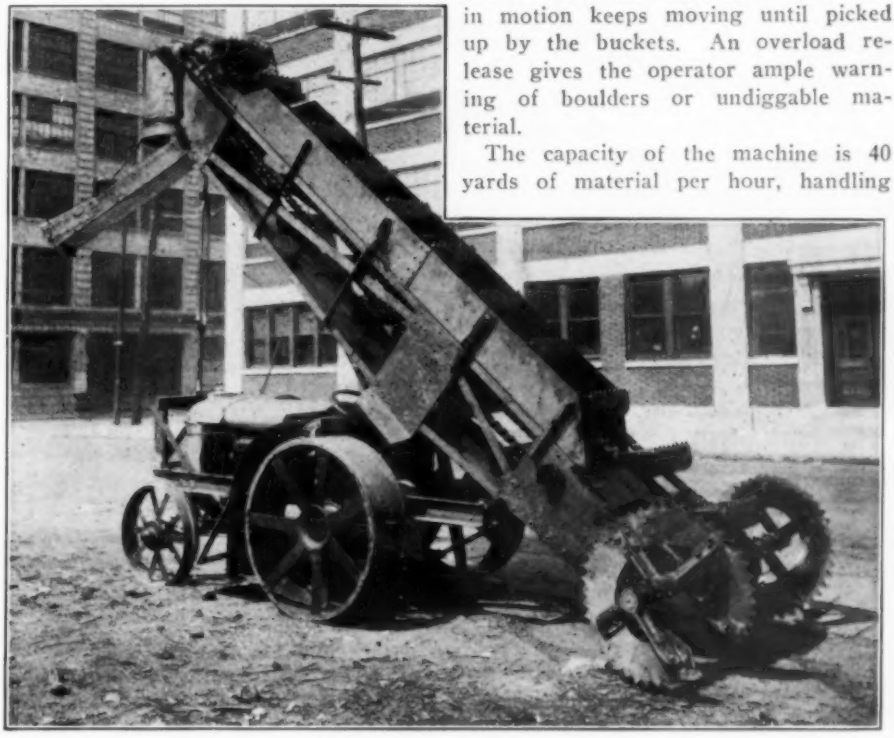
E. Ronceray of the firm of P. H. Bonvillain & E. Ronceray, Paris, presented a paper on this subject, dealing specifically with iron castings, before the London branch of the Institution of British Foundrymen. This paper was published in THE FOUNDRY Oct. 15, 1922. Mr. Ronceray stated that he was not prepared to advance a hypothesis explaining the apparent phenomenom he simply stated the result of his own experience and observation extended over a considerable period. The article is illustrated with numerous line drawings and photographs illustrating the method of gating the castings to secure solid castings without resorting to the accepted use of risers or feelers of any kind.

Loader is Mounted on Standard Tractor

For use in loading sand, coal, etc., in various parts of the foundry, the N. P. Nelson Iron Works, Inc., Fortieth street, Brooklyn, N. Y. recently has introduced a self feeding bucket loader which is mounted on a standard Fordson tractor The new loader is capable of traveling around the plant at a speed up to 12 miles per hour. A view of the self propelling type loader is shown in the accompanying illustration.

The operator stands on a platform at the side of the machine with all control levers in reach and with an unobstructed view of the entire digging and loading operation. Another feature of the new development is the fact that the elevator is direct connected to the engine, allowing the elevator to run full speed while the tractor is inched backwards into the disappearing pile. The spirals level a six foot cut and material once started in motion keeps moving until picked up by the buckets. An overload release gives the operator ample warning of boulders or undiggable material.

The capacity of the machine is 40 yards of material per hour, handling material that can be shoveled without the use of a pick. A governor controls the consumption of fuel to the actual requirements. A swivel spout it attached to the loader permitting discharge sideways into a truck if necessary An 8½-foot clearance is provided under the discharge chute.



SELF FEEDING BUCKET LOADER WHICH MAY BE MOVED UNDER ITS OWN POWER

Monmouth, Ill. is interested in securing a foundry which would be supported by local manufacturers.

Machinery Sales Are Lighter

Seasonal Decline Noted in Demand for Foundry Equipment, Although Foundry Activity Continues and Inquiries Are Plentiful— Cleaning Room Sundries Find Sale

MIDSUMMER usually brings a lull in foundry activities. While this condition does not govern at present, as practically all shops are operating well up to schedule, a slackening is apparent in sales of foundry equipment. An exception is noted in the case of cleaning room requirements, which seem as active as before. Recent sales of the Pangborn Corp., Hagerstown, Md. include a dust arrester for the Massillon Steel Casting Co., Massillon, O. The Ferro Machine & Foundry Co., Cleveland has purchased two additional room-type sand blasts with dust arresters from the W. W. Sly Mfg. Co. Cleveland. Other sales by the same interest include tumbling mills to Leonard & Baker Stove Co., Taunton, Mass., and the Gartland-Haswell Foundry Co., Sydney, O., sand blasts to the Falcon Bronze Co., Youngstown, O. and tumbling mills, sand blast and dust arresters to the American Gear & Mfg. Co., Jackson, Mich. The T. H. Symington Co., Rochester, N Y. will alter its main foundry building, installing a cross monitor room.

Holiday Limits Pittsburgh Sales

SHUTDOWNS over July 4 and for making needed repairs, etc., have limited the sale of foundry equipment in the Pittsburgh area for the past two weeks. Several molding machines have been disposed of over a widespread territory and many more are pending in the way of live inquiries. Various kinds of flasks, steel, pressed steel, and iron, have been sold in fair sized quantities although instead of 300 to 400 at a time the rate of buying has been 50 to 125 at a time. One or two cupola inquiries still are out, including one from the Davies & Thomas Co., Catasauqua, Pa., which possibly will purchase other equipment as well for the production of heavy castings. Only one or two core oven propositions are pending here and no new inquiries are noted for sand blast equipment or sand handling machines. The sale of one or two ladle driers for gray iron castings is noted. The National Engineering & Machine Co., Sharpsburg, Pa., possibly will purchase some machinery at an early date for a $50,000 addition. The Chemung Foundry Co., 500 Erie street, Elmira, N. Y., is perfecting plans for a one-story addition. The Dayton Steel Foundry Co., Dayton, O., is erecting an addition to its plant, and is installing an air compressor and other equipment. The Acheson Mfg. Co. at Rankin, Pa., recently suffered loss by fire to the extent of approximately $75,000. It plans to rebuild and some equipment will have to be purchased. Several cranes and hoists have been bought by foundry interests recently, including the Westinghouse Electric & Mfg. Co., East Pittsburgh which likewise has purchased foundry equipment for some of its various plants. The Westinghouse company bought one 10-ton and two 3-ton cranes from the Northern Engineering Works, Detroit, and two 5-ton cranes from the Whiting Corp. Harvey, Ill. The Reliance Steel Casting Co., Pittsburgh, closed on a 5-ton crane with 29-foot span through the Pittsburgh Crane & Equipment Co., order to go to Alfred Box & Co., Inc., Philadelphia. The Railway Steel Spring Co., Latrobe, Pa., wants two 15-ton cranes, double-drum type, and the Carnegie Steel Co. want two locomotive cranes for its Mingo Junction and Bellaire, O. plants. The Standard Steel Works, Burnham, Pa. will install three complete room type sand blasts with dust arrester equipment, contracted with the Pangborn Corp., Hagerstown, Md.

Eastern Sales Slacken

THE NEW quarter has started off somewhat slowly in the eastern foundry equipment market. Reduced operations at some plants due to the warm weather and the holiday early in the month are mentioned as contributing factors. Another consideration is the fact that of late there have been few new projects or additions. Some new construction is in contemplation such as a new foundry for the Wincroft Stove Works, Middletown, Pa., to be erected at Florin, Pa., and the proposed new plant of the Barnes Foundry Co., Freeland, Pa., to be erected at Jersey City. However, these jobs have not advanced sufficiently to require equipmnt. A recent buyer has been the Robins Conveying Belt Co., Passaic, N. J., which has closed on a cupola to the Whiting Corp. Harvey, Ill. The American Car & Foundry Co. New York, has closed on a number of ladles and the National Foundry Co., Brooklyn, has purchased one, both orders going to the Whiting Corp., which has also been awarded a cupola by the Davenport Sash Weight Co., Davenport, Ia. The Seaboard Air Line is figuring on some foundry equipment, including a new cupola. The American Car & Foundry Co. is also figuring on some additional foundry equipment. The Burnham Boiler Co., has contracted for sand blast and dust arrester equipment for its Elizabeth, N. J. and Lancaster, Pa. plants from the Pangborn Corp., Hagerstown, Md. The Barlett Hayward Co., Baltimore, is installing a dust arrester in its new foundry, purchased through the same interest.

Prices at present are showing little change. One manufacturer, however, expects to increase quotations on sand blast equipment by about 15 per cent shortly. Advances recently in motors are expected to be reflected in some lines where electrical attachments are used. Deliveries for the most part are steady. The Mott Sand Blast Mfg. Co. recently has placed equipment with the Neptune Meter Co., Long Island City, N. Y., the Brooklyn Vault Foundry Co., Brooklyn and the American La France Co., Bloomfield, N. J.

Chicago District Market Soft

AS USUAL during July and August, the market for foundry equipment at Chicago is somewhat slower than earlier in the year, but from all indications the lull is not greater than the mid-summer season usually produces. In spite of the lessened buying, manufacturers of this class of equipment are busy, as sales earlier in the year were sufficiently large to give them a backlog to last over the dull season. A recent sale of interest involves the entire equipment for a municipal foundry for the City of Mexico, including a cupola, brass furnaces, core ovens, tumblers and ladles, which will be furnished by the Whiting Corp. Harvey, Ill. The same seller has taken a 45-inch cupola for the Columbus Steam Pump Co., Columbus, Ohio. Crane sales continue to be a feature of the market and the Whiting Corp. has booked a 20-ton hand power crane and a pillar crane for the Schenectady plant of the General Electric Co., and

a 5-ton crane for the Banner Iron works, St. Louis. Buying of large flask equipment is being done by some important interests and a Chicago foundry recently bought about $30,000 worth of large steel flasks in a single lot. Demand for molding machines keeps up reasonably well, especially for some of the larger units and Chicago manufacturers of this class of equipment are booking sufficient business to keep them well occupied. Sales of sand conditioning equipment are being made to foundries in all parts of the country, with frequent inquiries and some orders from foreign lands. Recent sales of sand blast and dust arrester equipment made by the W. W. Sly Mfg. Co. in the western territory include those to Phillips & Buttorff Co., Nashville, Tenn., Stearns Motor Mfg. Co., Ludington, Mich. and the American Steel Foundries, East St. Louis, Ill. The Jenkins Machine Co., Sheboygan, Wis., Buick Motor Co., Flint, Mich., Michigan Malleable Iron Co. Detroit and the Holmes Foundry Co., Port Huron, Mich. have purchased sand blast and dust arrester installations from the Pangborn Corp., Hagerstown, Md. Inquiries are somewhat easier along these lines.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

A contract has been let by the Ware Foundry Co., Ware, Mass., for the rebuilding of its plant which was damaged by fire recently.

The Charter Gas Engine Co., Sterling, Ill., is understood to be contemplating the erection of a 1-story addition to its plant.

The plant of the National Casting Co., Marietta, Pa., recently was damaged by fire. It is understood it will be rebuilt immediately.

The Foster Stove Co., Ironton, O., recently awarded a contract for the erection of an addition to its plant.

The Ironton Stove & Mfg. Co., Ironton, O., is reported to be planning the erection of a modern foundry building.

The Magee Furnace Co., Boston, is converting a plant building at Taunton, Mass., for use as a foundry.

The Tallahassee Iron Works, Inc., Tallahassee, Fla., has started to rebuild its plant which was damaged by fire recently.

The Wincroft Stove Works, Middletown, Pa., is reported planning the erection of a foundry building and assembling works.

The Central Machine & Tool Co., Bartlesville, Okla., recently was incorporated with a capital stock of $50,000, by Lee Morrison, Morris Schuman and David L. Thomas.

The Lufkin Machine & Foundry Co., Lufkin, Tex., plans the erection of a 1-story plant building to be 45x200 feet, and to be erected at an estimated cost of $45,000.

The Orchard Fire-Pot Foundry Co., San Juan, Tex., recently was incorporated with a capital stock of $6000 by P. M. Perkins, Helen Perkins and B. L. Miller.

The Central Brake Shoe Co., Railway Exchange building, Chicago, is understood to be having plans prepared for the erection of a 1-story foundry building at Clearing, Ill.

The Favorite Stove & Range Co., Piqua, O., is understood to be having plans prepared for the erection of an enameling building, 43x68 feet, to be built at an estimated cost of $5,000.

Approximately $50,000 will be expended by the Baker Mfg. Corp., Saratoga Springs, N. Y., on the erection of a 1-story foundry building, which will be 50x112 feet.

Contracts have been awarded by the Standard Sanitary Mfg. Co. for the erection of a foundry and enameling building at Louisville, Ky.

The Dunn-Cooper Corp., Madison avenue, Binghamton, N. Y., manufacturer of metal patterns, is reported to be planning the erection of an addition to its plant to be built at an estimated cost of $25,000.

Capitalized at $87,500 the Connecticut Electric Steel Casting Co., Hartford, Conn., recently was incorporated by Frank M. Livingstone, John W. Sarles, Bridgeport, Conn., Lester D. Dame and others.

With a capital stock of $1,250,000 the John Polachek Bronze & Iron Co., New York recently was incorporated by J. and S. Polachek and E. H. Geiger. The company is represented by S. Hellinger, 305 Broadway.

The Republic Radiator Corp., Utica, N. Y., recently organized with a capital stock of $150,000, plans to establish a plant here, employing about 100 men, to be devoted to the manufacture of steam and water radiators.

The National Engineering & Machine Co., Sharpsburg, Pa., plans the erection of an addition to its plant to be built at an estimated cost of $50,000. W. H. Caldwell is president of the company.

Ground for a new plant at Greenwood, Ind., for the Indianapolis Pump & Tube Co., Kentucky avenue and Drover street, Indianapolis, recently was broken. It is expected the new plant will be ready for occupancy about Dec. 1.

The American Sash Weight Foundry Co., Davenport, Iowa, plans to purchase the former plant of the Sears Tire & Equipment Co., on West Second street, which it will utilize as a plant.

Advices have been received from the Leonard Range Co., Washington, Ind., to the effect that it will erect a 1-story plant building, 60 x 305 feet, to be of brick and steel construction. It has the necessary equipment for the plant with the exception of that for the nickeling department, which it will purchase.

The Belmont Smelting & Refining Works, Brooklyn, N. Y., recently was incorporated under the laws of New York state with an active capital stock of $10,000. It was incorporated by G. and V. Henning and L. O. Jury. The company is represented by Thornton & Earle, 15 William street.

The Saginaw Pattern Works, Saginaw, Mich., recently was organized to engage in the manufacture of patterns for brass and aluminum castings, by Albert J. Fox, formerly superintendent of the pattern department of the Buick Motor Car Co. and C. C. Wood, who formerly was connected with the Central Foundry of Saginaw.

Through C. C. McKallip & Co. the Pittsburgh Malleable Iron Co., Pittsburgh, recently purchased the former Wainwright brewery of the Pittsburgh Brewing Co. in Lawrenceville, Pa. The property fronts 95 feet in Thirty-sixth street and is 333 feet in depth along Charlotte and Smallman streets. It is improved with several warehouses. The Pittsburgh Malleable Iron Co. after making extensive alterations and erecting some new buildings will occupy the premises.

Announcement has been made by the Franklin Machine Co., Providence, R. I., of its recent purchase of the American & British Mfg. Corp. including the latter's original drawings and patterns. The Franklin company was incorporated in 1885. It is one of the oldest manufacturers of machinery and iron castings in Rhode Island. In 1916 it was taken over by new management and in 1918 the growth of the business necessitated expansion of its plant and the William A. Harris Steam Engine Co., Providence, was absorbed with all records, drawings and patterns of the Harris-Corliss stationary engine. The company's acquisition of the American & British Corp.'s patterns and drawings, enables it to furnish the trade with either Harris-Corliss, George H. Corliss, Green-Wheelock or American diesel type engine units.

New Trade Publications

ARC WELDERS.—A 4-page illustrated folder has been published by the Allan Mfg. & Welding Corp., Buffalo, in which electric welding with polyphase alternating current arc welders is described and illustrated. These arc welders are constructed for primary voltage and cycle.

SAND CUTTING MACHINE.—The American Foundry Equipment Co., New York, has published a 4-page illustrated folder in which a foundry sand cutting machine is described and illustrated. This machine has a depth of cut up to three feet, and it completely cuts and piles a heavy 30-foot floor in four to five minutes, according to the folder.

PNEUMATIC ROTARY BRUSH.—J. W. Paxson Co., Philadelphia, has published a circular in which a pneumatic rotary brush is described and illustrated. The object of the brush is to clean flat surfaces such as iron, steel and brass castings, steel cars, trucks, wagons, tanks, steel and iron sheets, stone, cement, wood, etc. Specifications are length overall, 12 inches; weight 7½ pounds;

air inlet, ½ inch; air pressure, 50 pounds and speed, 5000 revolutions per minute.

IRON PURIFIERS—A small folder published by the Metal Laboratories Inc., Detroit, Mich., describes a new product. Attention is called to the fact that metal purifiers are usually put in the ladle, while this material is put directly into the cupola. Among the claims made for the product are reduction of sulphur, elimination of hard spots and a minimum of blowholes.

BOILER STOKER—Longitudinal and cross-sectional views of the stoker made by the Combustion Engineering Corp. New York are shown in a four page folder recently issued. It is claimed that the stokers are adapted to small plants. Attention is called to the other types of stokers put out by this company which include pulverized fuel, oil burning, traveling grate and hand stokers. A record of a test conducted on the new type stoker is included.

DIAL SCALES.—A 12-page booklet has been published by the Howe Scale Co., Rutland, Vt., giving a brief description of its products. Attention is called to the special features of the scale, the ball bearing mountings, the plain figured dial and other features said to be used exclusively by this company. A standard list of the scales regularly carried in stock takes up several pages of the booklet.

FOUNDRY MATERIAL HANDLING EQUIPMENT—Under this title the Link-Belt Co., Chicago, has issued its Book 690, describing its various classes of conveying equipment for foundries. These include locomotive cranes, belt conveyors, mold conveyors, sand handling equipment and devices for preparing and revivifying the molding sand. While considerable space is devoted to descriptions, the bulletin is largely given over to halftone illustrations showing actual installations of equipment.

AIR HOISTS, SINGLE DRUM TYPE.—A single drum type of air hoist is described in a new booklet prepared by the Sullivan Machinery Co., Chicago. The motor used in this hoist is similar to the one used in a coal cutter which has been on the market for some time and put out by the same company. The principle of operation is clearly described. The capacity is 2000 pounds lifted vertically at the rate of 110 feet per minute at 75 pounds air pressure.

STEEL PLATE TROLLEYS—Both plain and geared steel plate trolleys made by the Yale & Towne Mfg. Co., Stamford, Conn., are described in a small folder published by this company. According to the description, the trolleys are made to withstand severe overloads. They are equipped with roller bearings and chilled cast wheels which conform to the curvature of the track, adding to the life of the trolley. Other features said to be incorporated in the equipment are flexibility, ease of operation and safety.

DUST ARRESTERS—The American Foundry Equipment Co., New York, has published an 8-page illustrated bulletin in which dust arresters are described and illustrated. This bulletin is the first of a complete set of loose-leaf sand-blast bulletins to be printed. It explains the advantages of the cloth screen type of arrester and treats in detail the essential features for an efficient installation. The influences of air leakage, overloading the arrester, cleaning the screens, and capacity ratings are explained.

ROOF VENTILATORS.—The Tarpenning-LaFollette Co., Indianapolis, has published a 4-page illustrated folder in which roof ventilators are described and illustrated. These are made in either stationary or rotary types. In addition to this bulletin the company has published a 32-page illustrated booklet in which dust collecting systems, ventilating, drying specialties and other industrial sheet metal work is described and illustrated. The company manufactures complete systems for dust and shavings collection, ventilating, heating or drying for industrial plants.

CRUCIBLES—Numerous illustrations, cross-sectional views, and lists of standard sizes of crucibles, phosphorizers, skimmers, ladles and retorts feature a recent publication of the Tacony Crucible Co. Philadelphia. Special types and sizes are also listed together with stoppers, nozzles and sleeves. A portion of the book is given over to illustrations in and about the plant and a number of pages are devoted to the care and handling of this equipment in the foundry.

SAND MIXER—A double-shaft propeller-type belt-driven sand-mixing machine is described in a bulletin recently issued by the Pneulec Machine Co., Ltd., Smethwick, near Birmingham, England. Although designed primarily for core sands this machine can also be used for mixing molding sands. Two views of the machine are illustrated and it is fully described in the bulletin. The mixing box of the machine is divided into two compartments by a longitudinal partition, the propellers being so arranged that the sand travels the full length of both compartments.

PNEUMATIC CONVEYING—The Dust Recovering & Conveying Co., Cleveland, has published a 4-page circular in which a pneumatic conveying installation used for unloading bulk material from cars is described and illustrated. The two outlays presented in the circular are of installations which have been in operation for some time in unloading fine materials from box cars. The drawings show materials being drawn from car, lifted to a considerable distance, then conveyed horizontally, collected and discharged direct into a storage bin, or elevator.

GRINDING WHEELS—A small 28-page booklet on grinding wheels has been put out by the Norton Company of Worcester, Mass. A brief account is given of the various products entering into the manufacture of grinding wheels. Special attention is given to the meaning of the markings on the wheels and an explanation of the terms grain and grade as applied to grinding wheels. Correct methods for mounting, rules for calculating speeds, tables for grinding wheel speeds and illustrations of wheels faces also are given.

GRINDING WHEEL SELECTION—This is one of a series of six booklets published by the Norton Company, Worcester, Mass. While devoted primarily to the company's products yet the data are applicable to other types of grinding wheels. Attention is given to the condition under which the wheel must operate, the material to be ground and the variable factors such as, wheel speed, work speed and the human element which always enter into any mechanical operation. One half of the book is devoted to a table of the company's recommendations of wheels for specific purposes.

TOOL AND CUTTER GRINDING—This handbook of tool and cutter grinding was prepared by the Norton Company, Worcester, Mass. It gives in detail the procedure to follow in grinding milling cutters of all kinds, cutters with inserted teeth, counter-boring tools, reamers, gear cutters, etc. as well as grinding plane and beveled surfaces, internal grinding and polishing operations. Part of the book is devoted to illustrations and descriptions of the grinding machines made by this company as well as cross-sectional views of wheels and power transmission equipment. A comprehensive index is included.

MOLDING MACHINE.—A large 28-page illustrated booklet has been published by the Beardsley-Piper Co., Chicago, in which its sandslinger molding machine is described and illustrated. According to the booklet, this machine throws 750 to 1800 handfuls of sand per minute. It rams flasks of any size, and it does not require deep or expensive pits and heavy foundations. It is built in four types: Stationary, tractor, portable and locomotive. The various types are described in some detail and the illustrations show them in actual operation.

DUST ARRESTERS AND SAND BLAST MACHINERY.—The American Foundry Equipment Co., New York, is circulating six booklets in which its foundry equipment is described and illustrated. One booklet is devoted to describing and illustrating dust arresters; a second, sandblast barrels of the gravity and pressure type; a third, sand blast rooms of the down draft type and the humane type; a fourth, rotary table sand blast rooms; a fifth, automatic rotary sand blast tables for sand blasting articles requiring unusual care and a sixth, sand blast pressure tanks.

FOUNDRY EQUIPMENT—Holcroft & Co., Detroit, have published four circulars under one cover, each devoted to describing and illustrating various foundry equipment. The first bulletin is devoted to core and mold ovens. The second describes and illustrates furnaces for melting and annealing malleable iron; the third deals extensively with furnaces for melting and annealing steel and the fourth is devoted to heat-treating, carbonizing and annealing furnaces. In addition to a complete description of the various equipment, each bulletin contains a partial list of the users of the equipment, which the circular describes.

SANITARY BUBBLERS.—A 34-page booklet describing various types of sanitary bubblers, drinking fountains and ice-cooled fountains has been published by the Century Brass Works, Belleville, Ill. A full line of equipment suitable for use in the office, factory, school, or in fact anywhere where fresh water is required. The styles and materials are suitable for either outside or inside use. The ice-cooled fountain is made in sizes which according to the booklet will supply from 35 to 100 persons a day at a cost of only about one pound of ice a day. Various attachments for the fountains also are shown.

RECORDING EQUIPMENT—Two bulletins under one cover have been published by the Bacharach Industrial Instrument Co., Pittsburgh, in which pyrometer and recording equipment is described and illustrated. The first bulletin is devoted to describing and illustrating the ardometer and the optical pyrometer. The first is a new addition to the field of pyrometry and belongs to the general group of radiation pyrometers. It may be installed in places and for temperatures where neither rare nor base metal couples can be applied. The second bulletin describes a number of instruments including indicating instruments for blast-volume and pressure; recording equipment; pitot tubes and pressure gages for cupolas.

AIR HOISTS, DOUBLE DRUM TYPE.—In a bulletin recently put out by the Sullivan Machinery Co., Chicago, a hoist of the double drum type is described and illustrated. The outfit weighs 555 pounds or about 85 pounds to the horsepower, it is 29 inches long by 15 inches wide and 19 inches high. The motor which appears to be simple is fully described. Attention is directed to a turntable to be used with this hoist which will allow the position of the drums to be so adjusted that the cable will wind smoothly on the drum and not have a tendency to climb or rub against the flanges. Two charts are shown, one giving the lifting speed in feet per minute, the other the weight of material including cars which the hoist will pull up various grades.